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THE PHILIPPINE JOURNAL OF SCIENCE

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THE OCCURRENCE OF BERTIELLA IN MAN, MONKEY AND DOG IN THE PHILIPPINES

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FOUR PLATES

Early in 1934 we received from Doctor Gustilo for identification a tapeworm, which he recovered from his eight-year-old daughter, who had always resided in Sara, Iloilo Province, Panay. The tapeworm was a specimen of *Bertiella*. The general appearance of this tapeworm reminded us of a similar specimen that we had recovered at autopsy from the small intestine of a Manila dog five months previously. This specimen proved to be a *Bertiella* also, although it differs somewhat morphologically from our human material. While study of these two specimens was in progress, we received from Dr. Marcos Tubangui, of the Bureau of Science, Manila, three complete strobilæ of an apparently similar tapeworm, which he recovered at autopsy from the small intestine of a Philippine monkey (*Macacus cynomolgus*) in Rizal Province, near Manila, October 12, 1932. A study of this monkey material convinced us that, except for some insignificant difference, it is identical with our human material.

The interest that may be attached to this report is threefold: (*a*) a new area in the nosogeography of *Bertiella* is established; (*b*) a new case of *Bertiella* infestation in man is recorded; (*c*) the occurrence of *Bertiella* in the dog adds a new animal to the list of hosts for this genus. For convenience we shall call our

three lots of material by the names of their respective hosts in referring to them in this paper.

OUR HUMAN BERTIELLA

The human tapeworm, which was preserved in alcohol, appeared to be a complete strobila with the scolex missing. The entire specimen measures 160 millimeters in length.[1] The tapeworm broadens and thickens very gradually from the neck region posteriorly, being widest and thickest at about the middle of the specimen. Its broadest segments measure 11 millimeters in width, 0.2 millimeter in length, and 3 millimeters in thickness. The hindermost segments measure 7 millimeters in width, 0.45 millimeter in length, and 1.2 millimeters in thickness. The ripe segments are apparently shed not singly but in groups, since previous to the expulsion of this strobila a fragment of the tapeworm consisting of nine ripe segments was passed by the child.

Segments taken from various levels of the specimen were stained after the method of Ristroph (1934). Individual segments were also isolated, stained, and mounted in toto lying flat on their anterior or posterior border. This technic affords an unobstructed view of the internal structure, especially the reproductive glands and tubes, as it does away with the necessity of looking through the calcareous deposits and musculature, which obstruct the view when the segment is examined lying on its dorsal or ventral surface. Serial sections, longitudinal and transverse, of both mature and ripe segments stained after the above method were also prepared for study.

No description of the head can be given as this was missing in the specimen. The segments are broader than long; each segment contains a single set of reproductive organs; the genital atria alternate irregularly and are situated within the anterior half of the lateral margin of the segments. The dorsal excretory canal is smaller than the ventral excretory canal; the genital canals are dorsal to both the dorsal and ventral longitudinal canals.

Female reproductive organs.—The ovary is saddlelike in shape with its back directed ventrally when viewed laterally. Measuring about 1.8 millimeters from tip to tip in a transverse direction, it occupies about one-fourth of the whole width of the

[1] According to Dr. Gustilo the tapeworm when alive was capable of extending its length to as much as 16 inches, or approximately two and one-half times that of the preserved specimen.

mature segment, and is located well within the poral half of the proglottid. It consists of two large lobes connected with each other by a glandular bridge which communicates with a common stem. Each lobe consists of many long, fingerlike, tubular-sacular cytogenic glands with enlarged ends apparently originating from a common center. The vitellarium is also bilobed, and to some extent a copy of the ovary in general form and the relation of the lobes to each other. The lobes lie dorsally and behind the ovary, and being composed of numerous oval lobules with a tendency to form clublike ends radiating from a common center, may be mistaken for parts of the ovary. The shell gland is oval, situated dorsally and slightly anteriorly to the vitellarium. From this organ there arises a coiled tube, which empties into the receptaculum seminis. The receptaculum seminis, which is a thin-walled, oval vesicle measuring around 450 by 310 μ, lies dorsally and porally to the ovary, and anteroporally to the vitellarium, its ventral half being obscured by the latter organs when viewed from behind. The almost straight and slender vagina arises from it abruptly, like the stem of a pipe. At its point of origin may be seen clumps of deeply staining cells. The ovarian portion of the vagina, which dilates slightly after emergence from the receptaculum seminis, is about 900 μ long and 35 μ wide, while its muscular and glandular poral segment is about 400 μ long and 130 μ wide. In serial sections the poral portion of the vagina appears surrounded by a layer of deeply staining glandular cells, which seem to radiate from the lumen. The vagina, whose muscular lumen is plugged with a yellow pigmentlike material, lies alongside the cirrus in a common stroma. It opens into the common genital atrium behind and ventrally to the cirral opening. The uterus is in the form of a simple wavy tube across the segment with its trough and crest directed dorsoventrally.

In the ripe segment the medullary field is almost completely filled by the uterus, which is stretched transversely up to the lateral excretory vessels on either side in a corkscrew fashion. In serial sections it appears as a large tube with outpocketings packed completely with eggs that impart to it the appearance of a polygonal mosaic. The poral portion of the vagina persists in the ripe segment.

The eggs are roughly globular bodies with the following measurements: Outer eggshell, 55 to 73 μ in diameter; inner eggshell, 40 to 50 μ; embryo, 13 by 25 μ; hooklets, 9 to 10 μ. Freshly ob-

tained eggs from the uterus have their outer shell more or less crinkled; the embryo and the inner shell are obscured by coarse, refractile granules of varying size. After clearing, however, with Puri's fluid, the hexacanth embryo with its thick unstriated inner shell appears in full view. The egg thus cleared reminds one of the egg of *Hymenolepsis nana*. The pyriform apparatus is invariably present. It has the following average measurements: Length from base, 8 to 10 μ; width of base, 10 to 12 μ; distance of tip from outer eggshell, 15 to 18 μ.

Male reproductive organs.—The vas deferens runs towards the poral margin from the dorsal vicinity of the receptaculum seminis in three or four powerful sacculated loops before entering the thin-walled cirrus pouch, which lies dorsally and anterior to the poral portion of the vagina on the same plane as the excretory vessels. The vas deferens dilates immediately after entering the cirrus sac into a more or less globular, thin-walled seminal vesicle, which appears glandular at its junction with the straight, uncoiled, fairly muscular but slender cirrus that runs alongside of, and in close contact with, the vagina to the common genital atrium close to the opening of the vagina, somewhat dorsad and anteriad to the latter. The cirrus is unarmed and apparently unprotrusible. The testes are round or oval bodies, 78 to 80 μ by 60 to 70 μ, numbering from 200 to 250, disposed in one to eight layers, confined in the anterodorsal field of the segment. No testes are found on the ventral side of the vagina.

OUR MONKEY BERTIELLA

Our monkey *Bertiella*, preserved in 5 per cent formalin, is represented by three apparently complete strobilæ in each of which the scolex is present. It has the following measurements: Total length, 158 millimeters; greatest width, 14; greatest thickness, 4. Flattened and stained scolex measures 630 by 510 μ. The suckers have an average diameter of 255 μ. No pigmentation is noticed anywhere in the head. On comparing this material with our human *Bertiella* we noted that one is practically the copy of the other, except that the eggs of the human specimen are larger than those of the monkey specimen, a difference which we attribute to the different preservatives used.

OUR DOG BERTIELLA

Our material preserved in 5 per cent formalin consists of two specimens, a smaller, apparently immature worm about 50 millimeters long, and a larger, mature, and complete strobila, which has a total length of 190 millimeters. The short neck is immediately followed by the segments, which broaden and thicken very gradually posteriad. The unflattened scolex is subglobular and measures 900 by 650 μ. When flattened and stained it measures 820 by 560 μ. The proglottids are broader than long, and each contains a single set of reproductive organs; the genital pores alternate irregularly with a tendency to be unilateral. The mature segment is 0.7 millimeter long, 7.0 millimeters wide, and 1 millimeter thick. The dorsal excretory canal is smaller than the ventral excretory canal, and the genital tubes are both dorsal to both dorsal and ventral excretory canals.

Female reproductive organs.—The bilobed ovary, which measures 1.4 millimeters transversely, is crescent-shaped and located well within the poral half of the segment, occupying one-fifth of the width and almost the whole length and thickness of the proglottid. In transverse sections the two lobes appear to be joined together by a glandular bridge, which arises from a common stem. Each ovarian lobe hugs the corresponding lobe of the yolk glands which lie behind but in the same sagittal plane as the ovary. Sandwiched between the two lobes of the yolk glands lies the roundish shell gland, which sends out a short coiled tube that empties into the pyriform receptaculum seminis (300 by 135 μ), the latter being obscured by the poral lobe of the ovary. The vagina arises abruptly from the poral end of the receptaculum seminis and runs porally almost in a straight line until it reaches the plane of the excretory vessels, when it enlarges and becomes glandular and muscular to form its poral portion. This portion of the vagina runs alongside of the cirrus pouch and in close contact with it.

Male reproductive organs.—The testes are round or ovoid bodies, 70 by 60 μ, numbering between 75 and 100, confined in the anterodorsal field of the segment. Although a number of the testes are found on the poral side of the ovary, none is found ventrally to the vagina. The vas deferens arises from the vicinity of the poral lobe of the ovary, and after running poralwards in mighty convolutions, enters the pyriform cirrus

pouch (400 by 90 μ), which lies dorsally and behind the vagina. The seminal vesicle is a long cylindrical organ, which lacks the glandular elements found in the poral segment of the same organ in our human and monkey specimens. The apparently unprotrusible cirrus is long, slender, and straight. It empties into a short cloacal canal in common with the vagina before reaching the common genital atrium.

The description of the ripe segment of our human and monkey material applies to the dog specimen.

Although there are marked discrepancies between our dog material on the one hand and our human and monkey specimens on the other, we believe that the variations are not of specific significance.

According to Cram (1928) the genus *Bertiella* is composed at present of three species occurring in birds and nineteen species in mammals. The mammalian hosts are represented by rodents, marsupials, lemurs, and primates. However, a general review of the literature on the subject strongly indicates that many of these species are invalid or are subspecies of not more than two species. Thus, Baer (1927), quoted by Adams and Webbs (1933), reduces the recorded species of *Bertiella* to two—namely, *B. studeri* of the Old World and *B. mucronata* of the New—although the probability that *B. mucronata* is identical with *B. studeri* is pointed out by Cameron (1929). Southwell (1930) regards *Bertiella satyri* (Blanchard, 1891) Stiles and Hassal, 1902, *Bertiella conferta* (Meyner, 1895), *Bertiella polyorchis* Linstow, 1905, and *Bertiella cercopitheci* Beddard, 1911, as synonyms of *Bertiella studeri* (Blanchard, 1891) Stiles and Hassal, 1902. Joyeux and Baer (1929) also maintain the synonymy of *B. satyri* and *B. studeri*. Meggit (1927) considers the differences between *B. cercopitheci*, *B. mucronata*, *B. conferta*, *B. polyorchis*, and *B. studeri* to be nonspecific and such as might be produced by variations in the methods of fixation or degree of muscular contraction of the worms. It seems that *Bertiella fallax* alone, described by Meggit (1927) from *Cebus capuchinus* in Egypt, presents undoubted differential specific characters from the type species, *B. studeri*.

It appears, therefore, that the human infestation by this genus so far recorded is represented by only one species; namely, *Bertiella studeri* (Blanchard, 1891) Stiles and Hassal, 1902 (synonym, *B. satyri*).

Nine cases have been recorded so far of human infestations with *B. studeri*; namely, *Bertiella satyri* (Blanchard, 1891) re-

covered first from the orang-outang (*Simia satyri*) in Borneo, and later reported twice in man, first from a child in Mauritius (Blanchard, 1913) and then from a Bengali child (Chandler, 1925); the third case (*B. satyri*) was recorded from India (Mukerji, 1927) as occurring in a Hindu subject, although no account of the case was given; the fourth case appears to be *B. mucronata* (Meyner, 1895) Beddard, 1911, originally described from a Paraguayan black howler (*Alloutta caraya*) and reported by Cram (1928) as occurring in a young Spaniard in Cuba as well as in three young chimpanzees; the fifth record (*B. studeri*) was from St. Kitts (Cameron, 1928); the sixth (*B. studeri*) again from India (Maplestone, 1930), although in this case there seems to be some confusion about the uterus which in the author's text figure is represented as directly connected with, or rather emptying into, the deferent duct; the seventh case (*B. studeri*) was reported from Sumatra by Joyeux and Dollfus in 1931 (cited by Adams and Webbs, 1933); the eight and ninth cases (*B. studeri*) again in Mauritius (Adams and Webbs, 1933), the first from an 8.5-year-old creole child, and the second from a 4.5-year-old girl of Indian parentage borne in Mauritius. Our human case of *Bertiella* infestation represents the tenth and newest record of this genus in man and promises to involve a species different from the type species, *B. studeri*.

On comparing our human and monkey specimens with the type species, *B. studeri* (synonym, *B. satyri*) as described in Baer's account (Cameron, 1929), we found that our material differs particularly from the latter in the following respects: (*a*) The deferent canal of our specimens makes powerful sacculated coils before entering the cirrus sac, whereas in *B. studeri* the vas deferens is almost a straight tube before its entrance into the same organ; (*b*) the number of testes in our specimens is from 200 to 250, disposed in from two to eight layers—in *B. studeri* it is from 150 to 300, disposed in one or two layers; (*c*) the eggs of our specimens measure 55 to 73 μ, with a mean of ± 64.53 μ, and the embryos +16.6 μ, whereas in *B. studeri* they measure from 45 to 60 μ; the embryos, 10 to 16 μ. In view of the fact that although *B. satyri* differs from the type species, *B. studeri*, in that the ovarian portion of its vagina is enlarged as shown in Chandler's text figure (Chandler, 1925) and that there exist marked discrepancies in the disposition of the vagina and in the number of testes (only 100 in *B. satyri*) between the

two, yet the former is being considered a synonym of the latter; we, therefore, prefer to place our material provisionally under the type species, *B. studeri*, until the synonymy of the described species is definitely established. However, we feel justified in furnishing a detailed description of our material, because after all it may prove to be a new species.

In almost all recorded cases of *Bertiella* infestation in man, the subjects were young children. Mapleston (1930) has made the same observation. This phenomenon is shared by other rare human tapeworms; such as, *Davainea, Hymenolepsis, Dipylidium, Drepanidotænia,* and *Raillietina* (Faust, 1930). The authors (Africa and Garcia, 1934) report two cases of rare human tapeworm infestations; namely, (*a*) a case of a Filipino child two years old who passed spontaneously a small tapeworm, which they identified as *Davænia madagascariensis,* and (*b*) another tapeworm recovered from a hospital patient, a child also two years old, which proved to be *Raillietina garrisoni* Tubangui, 1931. The latter worm is a very common intestinal parasite of the Philippine brown rat (*Mus norvegicus* Erxleben, 1777). Joyeux and Baer (1929) are of the opinion that Garrison's *Davænia madagascariensis* and other rare human tapeworms are parasites of wild animals and accidentally transmitted to man. The fact that in most cases of rare human tapeworm infestations the subjects are young children seems to support further the hypothesis advanced by Looss (1911: 240) and shared by Sandground (1929), which seeks to explain the phenomenon of age resistance observed in certain metazoan infestations. This hypothesis is that the young of many different species of animals possess certain physiological characteristics in common, but as they grow older physiological changes along different lines develop, leading to the divergence observed in the adult. "In view of this it is reasonable to suppose that the closer the genetic relationship between two hosts, the more similar will be the conditions in those hosts when young, in so far as they will approach the requirements of the parasites for their existence. If the premise is not an erroneous one, it is not difficult to understand how a parasite, best adapted to live in one host, should be able to establish itself for a time in young individuals of another somewhat related host, yet fails to accomplish this as the host grows older and acquires specific characters that are unfavorable to the parasite."

The situation developing from the fact that most of the human infestations of *Bertiella* so far recorded have occurred in lands

where primates (orang-outang, chimpanzees, and monkeys) are in abundance and often in close association with human beings, seems to fit the hypothesis expounded above. The simultaneous appearance of *B. mucronata* in a young Spaniard and in the chimpanzees in Cuba (Cram, 1928), our own finding (this report) of *Bertiella* sp. in a child and a monkey in the Philippines, and the four reports on children from India and the nearby island Sumatra where monkeys thrive in abundance, seem to strengthen this hypothesis.

Exactly four months after receiving our human *Bertiella* from Doctor Gustilo, we received from the same source another specimen consisting of an apparently complete strobila minus the scolex, 20 centimeters long, with two groups of detached ripe segments, passed after administration of male fern. It is presumed that this specimen developed from the scolex that was left behind last April.

SUMMARY

Specimens of *Bertiella* species from a Filipino child, a dog, and a Philippine monkey (*Macacus cynomolgus*) in the Philippine Islands are described. This report provides the tenth and newest case in the list of this rare human-tapeworm infestation, establishes a new animal host for the genus, and defines a new area in its geographical distribution. A short discussion of the relation of tapeworms commonly infesting wild animals to the human host is given.

ACKNOWLEDGMENT

The writers are indebted to Dr. Marcos Tubangui, of the Bureau of Science, Manila, for his courtesy in placing his monkey material at our disposal; and to Dr. Jesus Gustilo, of Sara, Iloilo, for coöperating with us by presenting to our laboratory specimens of the tapeworm that were passed by his daughter.

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ILLUSTRATIONS

Plate 1

Fig. 1. Photograph of strobila of *Bertiella* sp. from man.
2. Microphotograph of ovum of *Bertiella* sp. from man.
3. Microphotograph of ovum of *Bertiella* sp. from man, after clearing with Puri's fluid showing the pyriform apparatus.

Plate 2

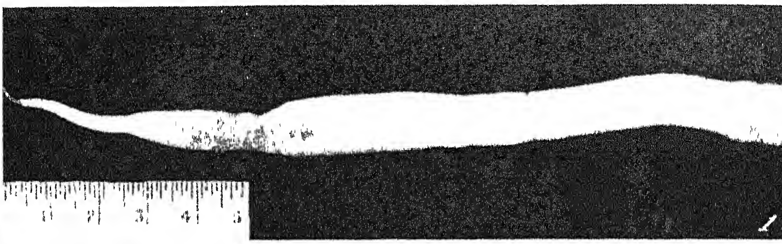
Fig. 1. Camera-lucida drawing of a mature segment of *Bertiella* sp. from man (lateral view).
2. Ripe segment of *Bertiella* sp. from man (lateral view).
3. Longitudinal section of a mature segment of the same tapeworm just medial to the genital pore.
4. The same segment at the level of the seminal vesicle.
5. The same segment as the above but at the level of the ovary.
6. Ventral view of *Bertiella* sp. from man, reconstructed from sections.
7. Camera-lucida drawing of ovum of *Bertiella* sp. from man.

Plate 3

Fig. 1. Scolex of *Bertiella* sp. from monkey.
2. Camera-lucida drawing of a mature segment of *Bertiella* sp. from monkey (lateral view).
3. A transverse section of a mature segment of *Bertiella* sp. from monkey.
4. Another transverse section of a mature segment of *Bertiella* sp. from monkey.
5. Ovum of *Bertiella* sp. from monkey.

Plate 4

Fig. 1. Free-hand drawing of a mature segment of *Bertiella* sp. from dog (ventral view).
2. Camera-lucida drawing of a transverse section of a mature segment of *Bertiella* sp. from dog.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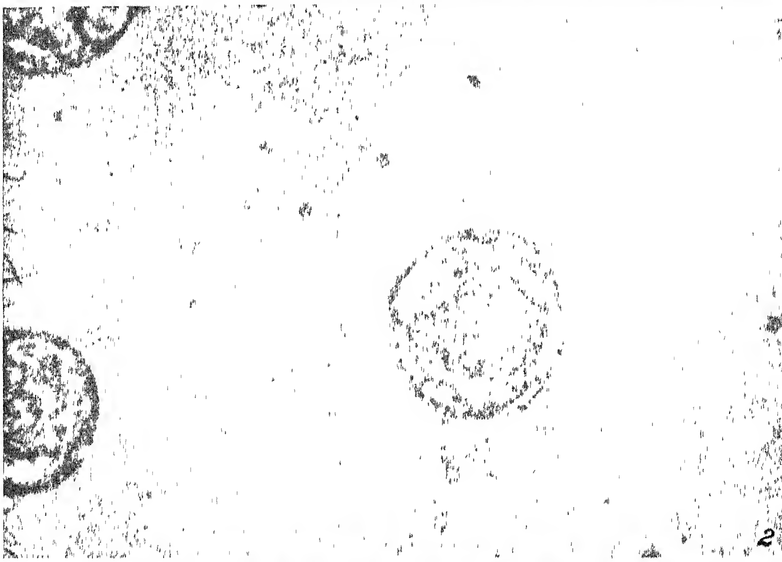
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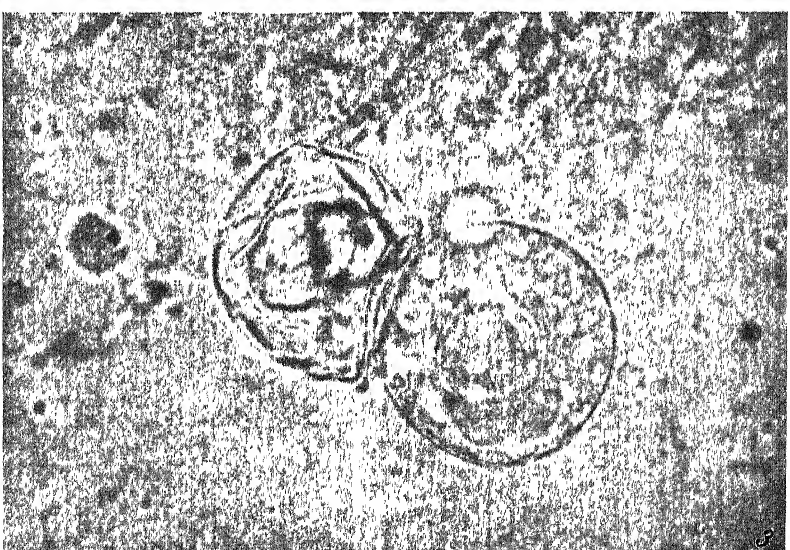
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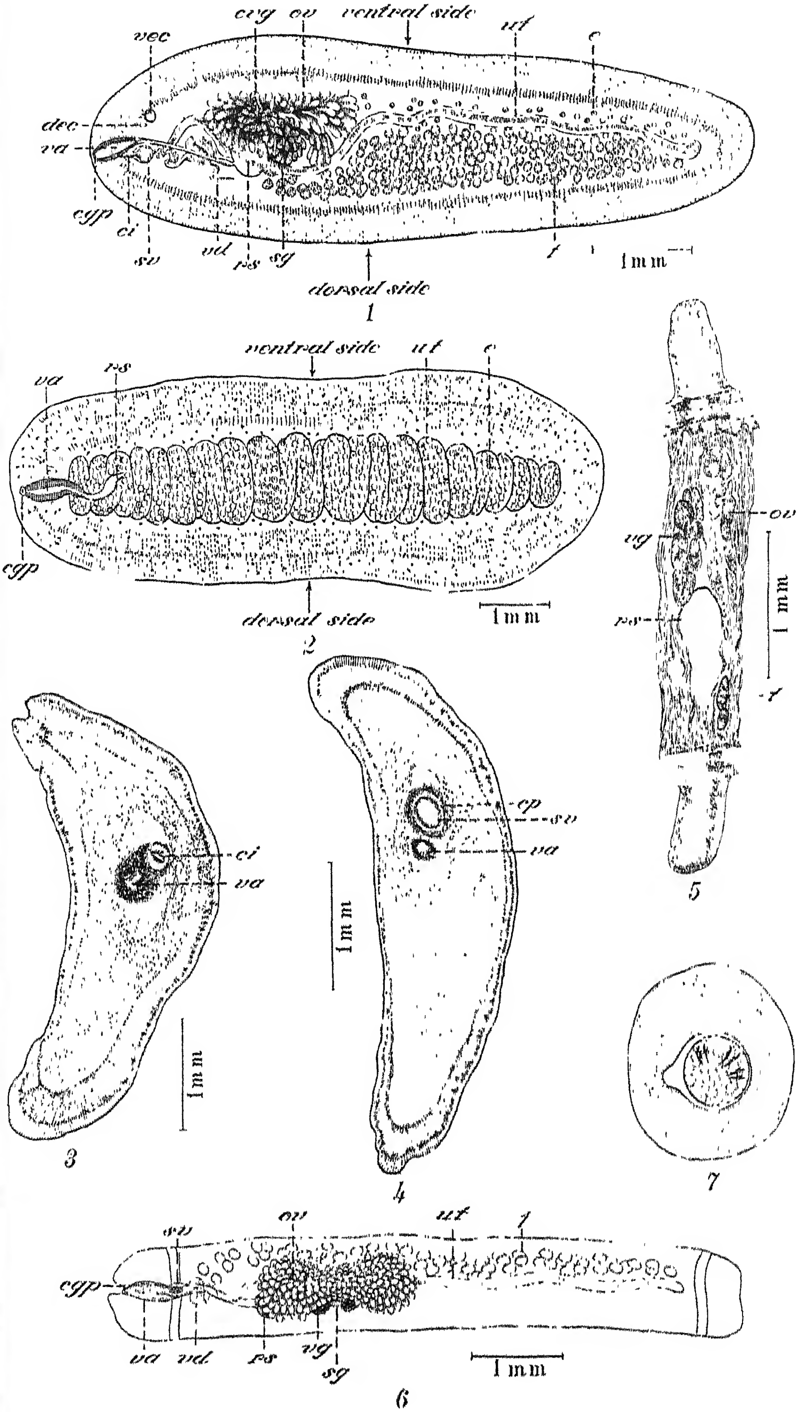
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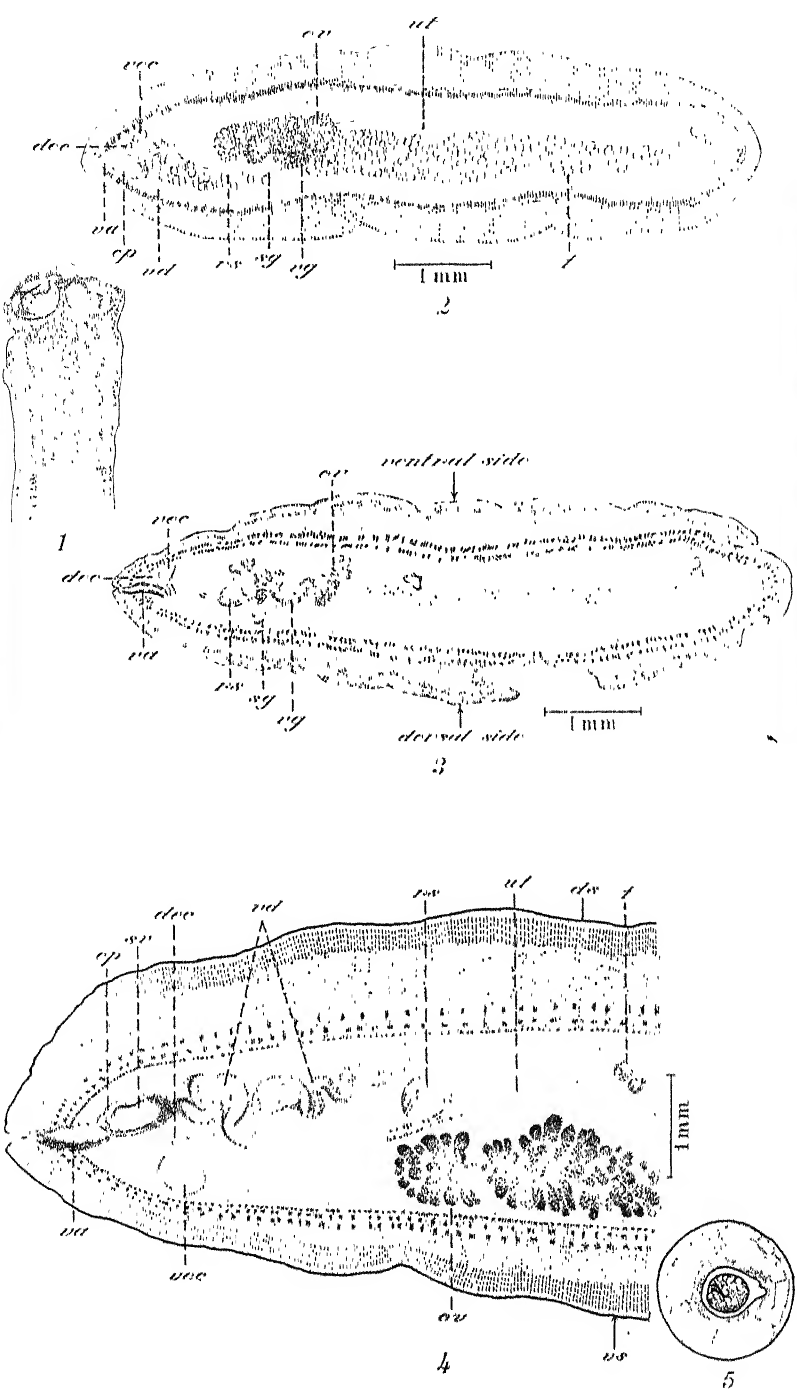
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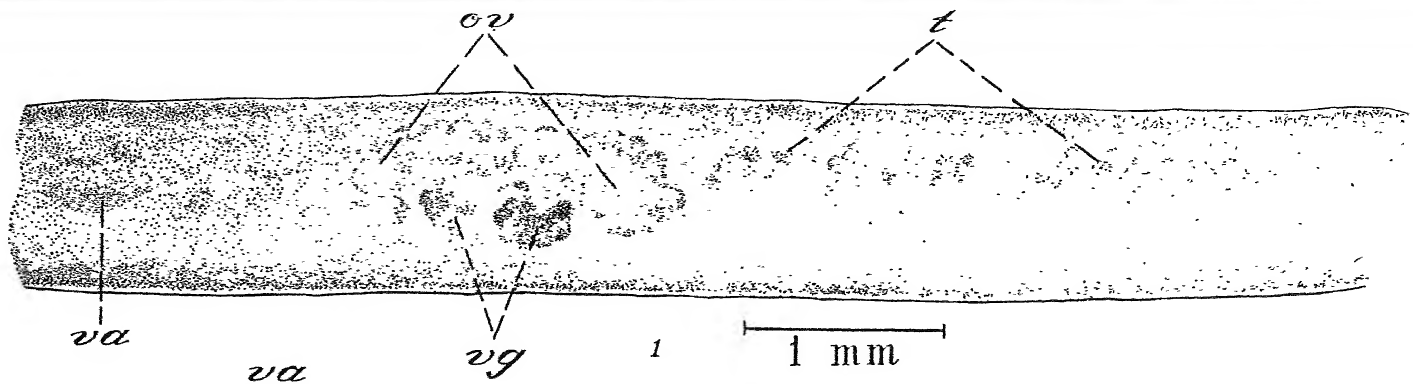
PLATE 3.



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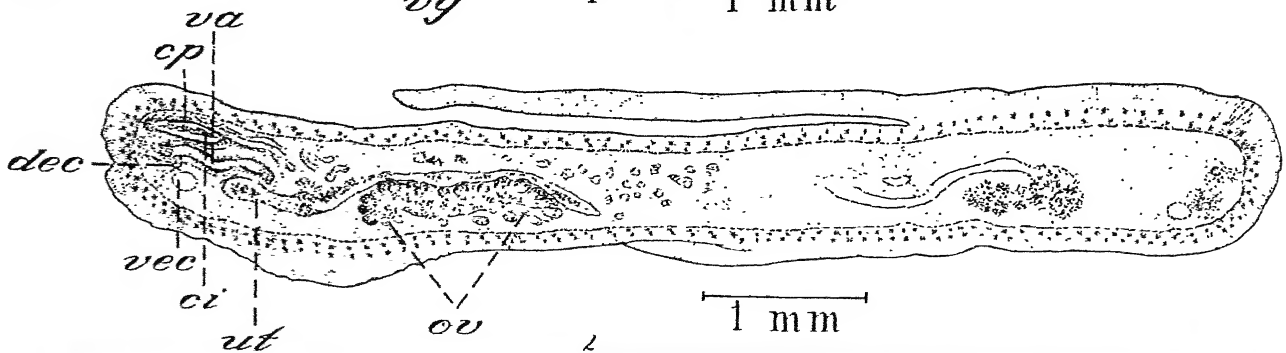

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PLATE 4.

ADDITIONAL NOTES ON PHILIPPINE ACANTHOCEPHALA

By MARCOS A. TUBANGUI

Of the Division of Biological Products, Bureau of Science, Manila

TWO PLATES

The four species of Acanthocephala described in this paper were collected from bird hosts by Messrs. A. Duyag and P. Rimando, to whom I wish to express my appreciation. Two of the parasites are represented by single specimens, for which reason it has proven difficult to make an accurate determination of their systematic affinities. For purposes of description they have been assigned to the genera *Oligoterorhynchus* Monticelli, 1914, and *Prosthorhynchus* Kostylev, 1916, as defined by Southwell and Macfie (1925).

Order ECHINORHYNCHATA

Family ECHINORHYNCHIDÆ Cobbold, 1879

POLYMORPHUS FRONTOSPINOSUS sp. nov. Plate 1, figs. 1 to 4.

Material.—Eight males and fourteen females, all mature, from the intestine of the common night heron, *Nycticorax nycticorax.*

This parasite was in the beginning thought to be identical with *Arhythmorhynchus hispidus* Van Cleave, 1925, a parasite of *Nycticorax nycticorax* in Japan, as described by Fukui (1929). Closer examination, however, revealed that it properly belongs to the genus *Polymorphus* Luehe, 1911, which, according to Travassos (1926), includes three species also parasitic in herons of the genus *Nycticorax.* It presents a great similarity to *Polymorphus mutabilis* (Rudolphi, 1819), from which it may be distinguished by the larger dimensions of its body and organs, the number of its proboscis hooks, and the uniform distribution of cuticular spines at the anterior region of its body.

Description.—Sexual dimorphism not strongly marked. Body more or less claviform, being swollen near anterior end and gradually tapering towards posterior extremity to a knoblike process which is especially noticeable in the female. Male meas-

ures 9.5 to 12.0 by 1.8 to 2.2 millimeters, female 12.5 to 15.0 by 2.0 to 2.5 millimeters. Cuticle from anterior end to posterior level of proboscis sheath in both sexes covered with numerous minute spines 10 to 12 microns long.

Proboscis subcylindrical, slightly swollen behind middle of its length, 0.70 to 0.80 by 0.25 to 0.32 millimeter in male and 0.80 to 0.92 by 0.30 to 0.34 millimeter in female. Except at its base, it is profusely covered with strong hooks arranged radially in eighteen to twenty alternating longitudinal rows of fourteen to fifteen hooks each. Hooks near middle of proboscis larger than those at anterior and posterior ends; they are 45.7 to 48.9 microns long and provided with rectangular roots 48.9 to 62.5 by 16.5 to 20.8 microns.

Neck absent.

Proboscis sheath double-walled, that of male measuring 1.28 to 1.90 by 0.28 to 0.50 millimeters and that of female 2.0 by 0.36 millimeters. Central nervous system immediately behind middle of length of proboscis sheath. Retinacula short, narrow.

Lemnisci slightly longer than, at most three-halves as long as, proboscis sheath. In male they barely reach the anterior level of the first testis.

Testes small, oval, very close together, one obliquely behind the other, at junction of first and second thirds of body length; they measure 0.42 to 0.90 by 0.36 to 0.70 millimeter. Prostatic glands tubular, six in number, compacted into an elongated mass 2.7 to 4.3 millimeters long. Cement reservoir 1.24 to 1.70 by 0.50 to 0.54 millimeters. Bursa relatively small.

Mature eggs in body cavity long, narrow, with three membranes, the middle one of which is thicker and with an outpocketing at each pole; they measure 104 to 120.6 by 29.1 to 33.3 microns.

Host.—*Nycticorax nycticorax.*

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 300.

MEDIORHYNCHUS SIPOCOTENSIS sp. nov. Plate 2, figs. 1 and 2.

Material.—One adult male and one adult nongravid female.

This parasite fits well in the genus *Mediorhynchus* Van Cleave, 1916, as redefined by Travassos (1924). In so far as the arrangement of its proboscis hooks in longitudinal rows is concerned, its nearest ally known is *M. oswaldocruzi* Travassos, 1923.

It may be distinguished from the latter by its smaller body size, its larger proboscis hooks, and its shorter lemnisci.

Description.—Sexual dimorphism marked. Body flattened laterally, broadest near anterior end; posterior end in both sexes bluntly rounded. Cuticle slightly rugose and presenting indications of pseudosegmentation. Male 5.7 millimeters in length by 1.2 millimeters in maximum diameter, female 12.5 by 2.2 millimeters.

Proboscis cylindrical to subcylindrical, truncated anteriorly, measures 0.42 by 0.32 millimeter in male and 0.52 by 0.46 millimeter in female; it is armed with prominent hooks arranged in twenty alternating longitudinal series of five or six hooks each. The hooks protrude through the centers of papilliform projections, the presence of which give the surface of the proboscis a rugged appearance. In the male the hooks (lamina) are 50 to 62.5 microns long and have rectangular roots 50 to 58.2 by 16.5 to 18.7 microns; in the female the lamina of the hooks are 62.4 to 66.5 microns in length and the roots 54 to 62.5 by 16.5 to 20.8 microns.

Neck well defined and like that of the proboscis its surface is rugged due to the presence of papilliform tubercles, through the centers of which small hooks protrude; in the male it measures 0.24 by 0.32 millimeter and in the female 0.30 by 0.60 millimeter. The hooks are arranged irregularly in about forty longitudinal rows of five or six hooks each; they are without roots and in the male they measure about 20 microns and in the female 25 to 33.3 microns in length.

Proboscis sheath poorly developed, single-walled, measures 1.04 by 0.35 millimeters in male and 3.03 by 0.82 millimeters in female. Central nervous system in middle of length of proboscis sheath.

Lemnisci of male 3.9 millimeters long by 0.2 millimeter in maximum diameter, those of female 6.2 by 0.2 millimeters.

Testes oval, tandem, partly overlapping, in third fourth of body length; anterior testis 0.98 by 0.38, posterior testis 0.76 by 0.42 millimeter. Prostatic glands eight in number, roundish, 0.10 to 0.12 millimeter in diameter, immediately behind testes. Cement reservoir 0.34 by 0.28 millimeter. Bursa small, invaginated.

Body cavity of female devoid of ova.

Host.—*Penelopides manillæ.*

Location.—Intestine.

Locality.—Sipocot, Camarines Sur, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 332.

PROSTHORHYNCHUS PITTARUM sp. nov. Plate 2, figs. 3 and 4.

Material.—One adult female.

Description.—Body plump, tapering towards both extremities, about 10 millimeters in length by 2 millimeters in maximum diameter; posterior end rounded, slightly curved ventrally. Cuticle unarmed.

Proboscis cylindrical, rounded at anterior end, 0.75 by 0.20 millimeter, armed with fourteen longitudinal rows of fifteen hooks each. Hooks 54 to 58 microns long and provided with roots 41 to 45 microns long.

Neck short, 0.12 millimeter long, unarmed.

Proboscis sheath with double walls, 1.6 by 0.4 millimeters. Central nervous system not evident.

Lemnisci narrow, 1.95 millimeters long.

Body cavity filled with numerous eggs, the apparently mature ones provided with three concentric membranes and measuring 125 to 130 by 45 to 50 microns. Genital opening ventrosubterminal at posterior end.

Host.—*Pitta atricapilla.*

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimen.—Philippine Bureau of Science parasitological collection No. 384.

OLIGOTERORHYNCHUS MALAYENSIS sp. nov. Plate 2, fig. 5.

Material.—One adult male.

Description.—Body quite slender, cylindrical, about 10.5 by 0.9 millimeters; posterior end bluntly conical. Cuticle smooth.

Proboscis subcylindrical, rounded at anterior end, 1.1 by 0.22 millimeters; base unarmed, the rest of its surface profusely covered with prominent hooks arranged radially in eighteen longitudinal series of twenty-one hooks each. Hooks on extreme anterior and posterior ends of proboscis smaller, with reduced roots, and 33.3 to 41.5 microns long; rest of hooks 41.5 to 49.5 microns long and with well-developed roots 37.5 to 41.6 by 16.5 microns.

Neck absent.

Proboscis sheath double-walled, 1.84 by 0.35 millimeters. Central nervous system in front of middle of length of proboscis sheath. Retinacula narrow, short.

Lemnisci narrow, 2.3 millimeters long.

Testes oval, one immediately behind the other, in middle of body length; first testis 0.85 by 0.40, second testis 0.88 by 0.36 millimeter. Prostatic glands four in number, tubular, forming a bundle 2.7 millimeters long. Cement reservoir 1.3 by 0.35 millimeters. Bursa well developed, about 1 millimeter across, arising from ventral aspect of posterior end of body.

Host.—*Hypotænidia philippensis.*

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimen.—Philippine Bureau of Science parasitological collection No. 380.

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ILLUSTRATIONS

[Drawn by Alfredo C. Gonzales.]

PLATE 1

POLYMORPHUS FRONTOSPINOSUS SP. NOV.

FIG. 1. Male, ventrolateral view.
2. Female, ventrolateral view.
3. Proboscis hooks.
4. Mature egg.

PLATE 2

FIG. 1. *Mediorhynchus sipocotensis* sp. nov.; male, lateral view.
2. *Mediorhynchus sipocotensis* sp. nov.; proboscis of female, lateral view.
3. *Prosthorhynchus pittarum* sp. nov.; female, lateral view.
4. Egg of *Prosthorhynchus pittarum* sp. nov.
5. *Oligoterorhynchus malayensis* sp. nov.; male, lateral view.

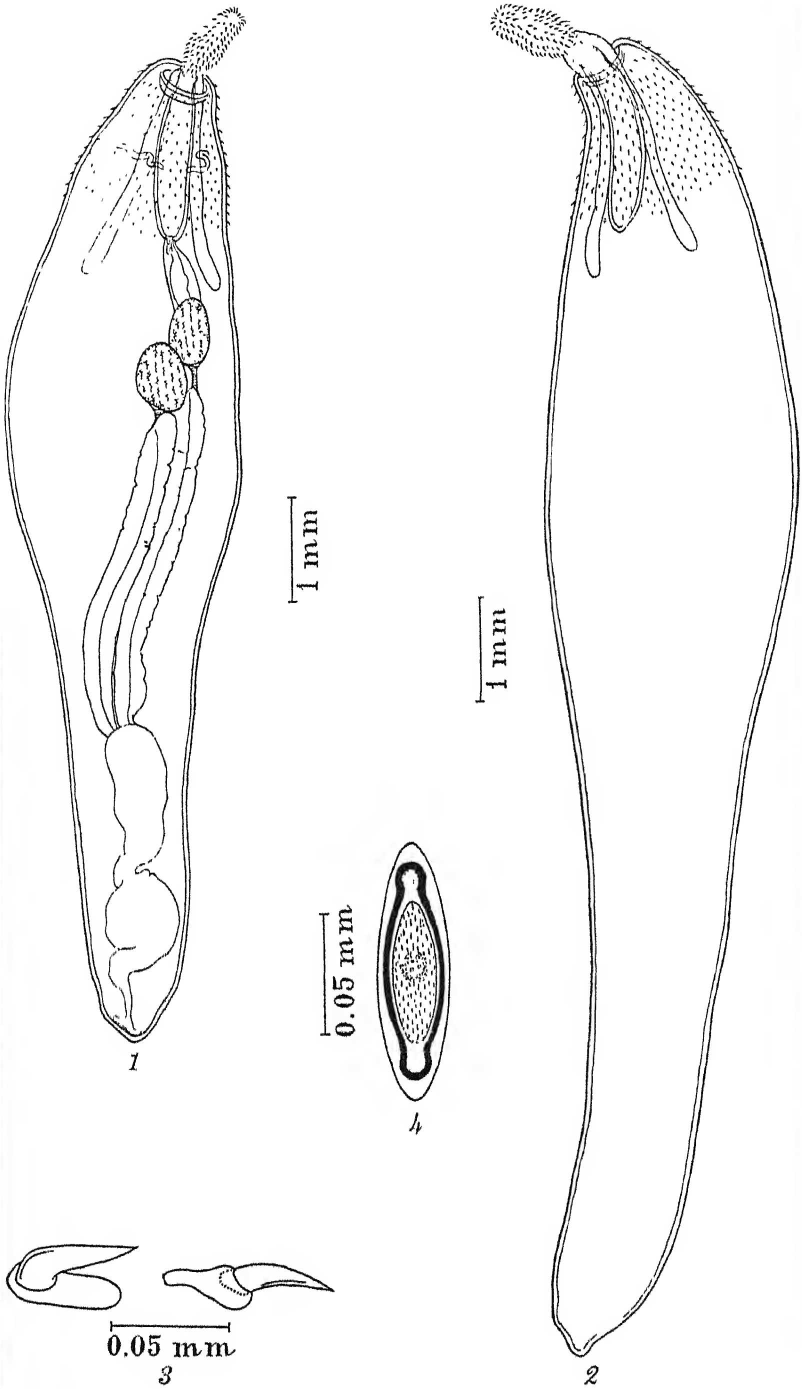

PLATE 1.

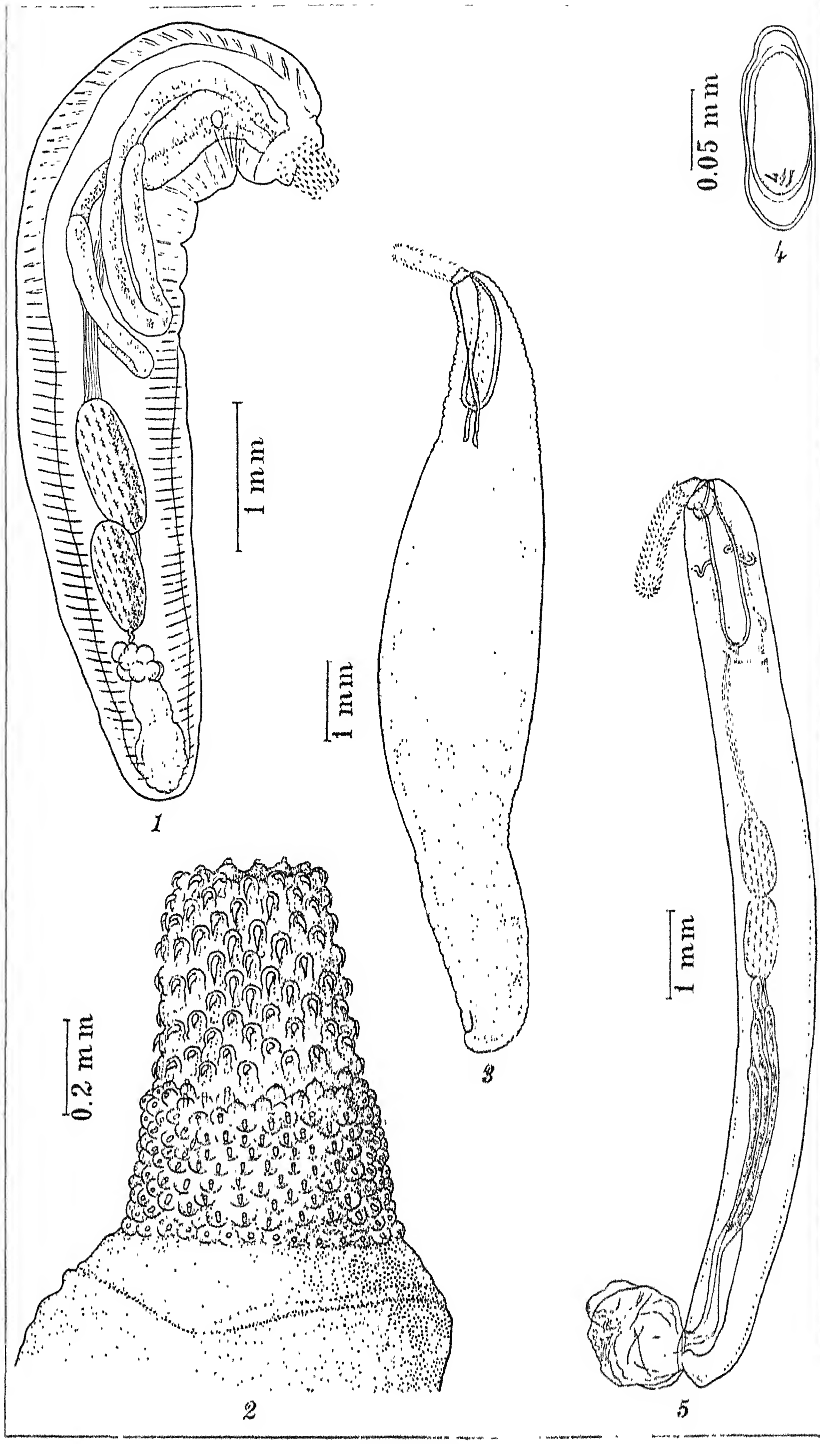

PLATE 2.

STUDIES ON THE DIASTOLIC BLOOD PRESSURE IN BERIBERI CASES ADMITTED TO THE PHILIPPINE GENERAL HOSPITAL DURING THE YEARS 1932–1934.

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INTRODUCTION

It is a well-known fact that beriberi occurs in rice eaters and is the result of some deficiency in the diet; namely, lack of vitamin B.

Judging from the report of the Bureau of Health, beriberi is a great public-health problem in the Philippine Islands, for although it is decreasing in Manila, it is increasing in the provinces, so that the total number of cases increases every year.

By courtesy of Prof. Luis Guerrero I was able to examine a few cases of beriberi confined in the Philippine General Hospital. It was found that the diastolic blood pressure in these cases was high compared with that observed in cases of beriberi in Japan, and the question arose whether or not race, climate, and food might explain this apparent difference. An examination was therefore undertaken of the clinical case records of beriberi cases admitted to the Philippine General Hospital during the period from May, 1932, to June, 1934, in order to determine if there actually existed any difference between the diastolic blood pressure of beriberic Filipinos and beriberic Japanese.

SYMPTOMATOLOGY

Beriberi is a composite of many symptoms, such as palpitation, œdema, digestive, sensory, and motor disturbances, etc., and recently Z. Shimazono(1) and K. Omori(2) have reported on the lowering of the diastolic blood pressure in beriberi compared with the normal average. This lowering, according to these authors, is also observed in experimental beriberi in human beings. Shimazono(1) states that this characteristic symptom is observed even in incipient cases of beriberi.

It has been found that the cause of this lowering of the diastolic blood pressure is a weakening of the arterial tension, and

does not depend upon a diminution in the blood quantity. It has also been observed that the tension of the heart and the peripheral vascular system is always more or less depressed in cases of beriberi.

Table 1, from a case reported by Shimazono, shows the lowering of the diastolic blood pressure in beriberi.

TABLE 1.—*Blood pressure of M. N., student, age 21 years (by Riva-Rocci).*

Date.	Systolic.	Diastolic.	Condition.
	mm Hg.	*mm Hg.*	
September 4	98	0	Very serious.
September 5	98-100	0	
September 7	125	0	Better.
September 10	126	35	Fair.
September 13	125	0	
September 21	122	0	
September 25	140	45	
September 30	151	47	
October 5	152	67	Very well.

In the systolic blood pressure beriberi causes no remarkable change. However, in serious cases a lowering of the systolic blood pressure may be observed, which becomes a fatal omen when it drops to 80 or 70 millimeters of mercury, according to Riva-Rocci. In some cases recovery from beriberi is associated with an increase in blood pressure above normal, reaching 150 or 160 millimeters of mercury even in young individuals, but returning gradually to normal upon recovery of the patient, as in the case by Shimazono (Table 1).

On the blood pressure in beriberi, especially the diastolic blood pressure, nothing has been written in the Philippines where beriberi is very prevalent. Therefore, it would be interesting and pertinent to investigate this problem.

STATISTICS

Much work has been done in the study of blood pressure among Filipinos. However, no author except Concepción(3) has reported anything on the diastolic blood pressure. His work has, therefore, proved invaluable to me, supplying me with the very much needed standard basis of comparison of diastolic [illegible]ure in Filipinos.

Following Concepción's classification,(3) I have divided my cases into eight groups by age and compared the diastolic blood pressure of beriberi with that of average normal readings.

Ninety-eight cases of beriberi were admitted to the Philippine General Hospital during the period from May, 1932, to June, 1934, of which forty-one, or 42 per cent were males, and fifty-seven, or 48 per cent, females.

Table 2 shows the incidence of beriberi according to decades of age, except for the cases between 15 and 20 years of age, studied by Concepción.

The incidence of beriberi is highest in individuals 21 to 30 years of age, especially females. Next in order come cases occurring in young people between 15 and 20 years of age, after which the tendency decreases with age. Beriberi is a disease that, like tuberculosis, is easily contracted by young adults between the ages of 21 to 30 years.

TABLE 2.—*Incidence of beriberi by age and sex.*

Age in years.	Males.		Age in years.	Females.	
	Cases.	Per cent.		Cases.	Per cent.
15–20	9	22.0	15–20	8	14.0
21–30	11	26.8	21–30	29	51.0
31–40	7	17.0	31–40	8	14.0
41–50	8	19.5	41–60	12	21.0
51–60	2	4.9			
61–90	4	9.8			
Total	41		Total	57	

Tables 3 and 4 show the relation between the diastolic blood pressure of the beriberi cases that I have collected and the corresponding normal average readings as reported by Concepción.(3)

Only two male and six female beriberi cases show higher diastolic blood pressures than the normal diastolic blood pressures reported by Concepción. In all other beriberi cases the diastolic blood pressure was always below the normal average. These findings agree with those of Shimazono and show that race, climate, and food, which on first sight seemed to exert some influence, actually have no effect. The average diastolic blood pressure observed in beriberi cases in the Philippines is the

same as that observed in beriberi cases occurring in Japanese in Japan. In the eight cases above showing diastolic blood pressure higher than normal, the systolic blood pressure was likewise remarkably higher than normal (Tables 3 and 4).

TABLE 3.—*Blood pressure in normal and in beriberic male Filipinos.*

Age in years.	Systolic.		Diastolic.	
	Concepción's readings, normal.	Beriberic.	Concepción's readings, normal.	Beriberic.
		mm Hg.		*mm Hg.*
15–20	110.7	118.0	77.6	70.0
		115.0		30.0
		110.0		80.0
		96.0		50.0
		119.0		50.0
		97.0		60.0
		96.0		71.0
		105.0		80.0
		100.0		50.0
21–30	111.9	90.0	76.6	50.0
		118.0		58.0
		112.0		60.0
		[b] 132.0		[b] 100.0
		106.0		58.0
		108.0		66.0
		120.0		64.0
		110.0		52.0
		108.0		60.0
		120.0		55.0
		118.0		80.0
31–40	118.8	118.0	80.3	70.0
		110.0		68.0
		122.0		78.0
		115.0		72.0
		100.0		65.0
		[b] 140.0		[b] 95.0
		85.0		42.0
41–50	125.4	115.0	86.6	70.0
		114.0		80.0
		122.0		82.0
		([a])		([a])
		100.0		60.0
		124.0		50.0
		114.0		58.0
		118.0		80.0
51–60	129.0	135.0	86.2	80.0
		130.0		50.0
61–90	137.8	125.0	91.6	70.0
		140.0		90.0
		95.0		62.0
		170.0		90.0

[a] No record. [b] Much higher than that of Concepción.

TABLE 4.—*Blood pressure in normal and in beriberic female Filipinos.*

Age in years.	Systolic. Concepción's readings, normal.	Systolic. Beriberic.	Diastolic. Concepción's readings, normal.	Diastolic. Beriberic.
		mm Hg.		*mm Hg.*
15-20	109.2	110.0	80.8	46.0
		[b] 140.0		[b] 88.0
		114.0		68.0
		110.0		70.0
		95.0		70.0
		110.0		80.0
		105.0		70.0
		98.0		60.0
21-30	118.1	110.0	84.1	68.0
		110.0		70.0
		98.0		60.0
		114.0		70.0
		[b] 135.0		[b] 90.0
		[b] 142.0		[b] 96.0
		112.0		70.0
		128.0		80.0
		115.0		60.0
		[b] 140.0		[b] 100.0
		112.0		80.0
		98.0		70.0
		120.0		54.0
		110.0		68.0
		104.0		86.0
		80.0		40.0
		108.0		68.0
		100.0		60.0
		[b] 152.0		[b] 92.0
		94.0		52.0
		110.0		70.0
		110.0		75.0
		150.0		85.0
		115.0		70.0
		130.0		84.0
		110.0		88.0
		([a])		([a])
		[b] 150.0		[b] 95.0
		105.0		65.0
31-40	118.2	118.0	85.1	70.0
		108.0		78.0
		145.0		82.0
		130.0		85.0
		125.0		45.0
		100.0		62.0
		134.0		76.0
		113.0		70.0

[a] No record.
[b] Much higher than that of Concepción.

TABLE 4.—*Blood pressure in normal and in beriberic female Filipinos*—Ctd.

Age in years.	Systolic.		Diastolic.	
	Concepción's readings, normal.	Beriberic.	Concepción's readings, normal.	Beriberic.
		mm Hg.		*mm Hg.*
		120.0		50.0
		78.0		30.0
		138.0		85.0
		110.0		62.0
		128.0		82.0
		98.0		52.0
41–60	132.9	135.0	90.5	80.0
		104.0		63.0
		120.0		60.0
		140.0		80.0
		146.0		64.0
		100.0		70.0

Tables 3 and 4 show that the difference between the systolic blood pressure of the above-excepted eight beriberi cases and the corresponding normal systolic average is greater than the difference existing between the diastolic blood pressure of these eight cases and the corresponding normal diastolic average given by Concepción, which further shows that there actually occurs an absolute lowering of the diastolic blood pressure in beriberi.

SUMMARY

1. The incidence of beriberi is highest in individuals ranging from 21 to 30 years of age, especially females, followed closely by young adults of 15 to 20 years. With advancing age there is a tendency for beriberi to decrease.

2. The diastolic blood pressure in beriberi is lower than the normal average diastolic blood pressure at a given age.

3. When the systolic blood pressure is higher than normal in beriberi, the lowering of the diastolic blood pressure is not evident.

ACKNOWLEDGMENT

In conclusion I wish to express my obligation to Prof. L. Guerrero, of the Philippine General Hospital, and Dr. M. Tubangui, of the Bureau of Science, for permission to carry on these studies.

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THE ATYIDÆ OF THE PHILIPPINE ISLANDS

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THREE PLATES

Fresh-water units of the Philippine Islands are generally richly inhabited by small prawns locally called *apta, yapyap* (Tagalog), *daliw-daliw,* or *koros* (Ilocano). These prawns belong to the family Atyidæ. They are abundant in large fresh-water lakes, especially Laguna de Bay and Taal Lake, where they are caught in large quantities by means of scissors-nets, such as the *salap* and *sakág.*

This crustacean is eaten fresh, or salted and made into a fermented product called *alamang.* It is also simply dried and sold as dry prawn. When the supply is abundant, it is prepared as protein feed for ducks and chickens or converted into some form of fertilizer. The local price of this product varies from 1 peso (50 cents United States currency) to 2.50 pesos a cavan.[1]

Although these prawns are widely distributed in the Tropics and Subtropics, very little has been written on their distribution and systematics in the Philippines. R. P. Cowles, formerly of the Department of Zoölogy, College of Liberal Arts, University of the Philippines, described the feeding habits of *Atya moluccensis* de Haan, so far the only described species in the Philippines. He indicated that there are several undescribed species of *Caridina,* which have feeding habits more or less similar to those of *Atya moluccensis.*

ATYIDÆ

In general, the first and second pairs of legs in the Atyidæ are comparatively small and of similar size. The chelæ are each fringed with a brush of long hairs. The family is represented in the Philippine Islands by *Atya, Caridina,* and *Ortmania,* which are believed to be more specialized than genera occurring in other countries.

[1] A cavan is 25 gantas. A ganta is equivalent to 3 liters or 3.3036 quarts.

The family Atyidæ is represented in the collection of the Bureau of Science by the following:

Atya moluccensis de Haan.
Atya serrata Spence Bate.
Caridina gracillima Lanchester.
Caridina gracilirostris de Man.
Caridina nilotica var. *brachydactyla* de Man.
Caridina modigliani Nobili.
Caridina brevicarpalis var. *endehensis* de Man.
Caridina laevis Heller.
Ortmania sp. (?).

Genus ATYA Leach

Atya Leach, Trans. Linn. Soc. London 11 (1815) 345.

Pairs of chelipeds quite similar; carpus reduced by the excavation of its distal border to a narrow crescent form; propodus modified, dactylus markedly developed so that the "palm" is entirely absent; chela composed of two similar parts.

Key to the known species of Atya in the Philippines.

a^1. Infraorbital and pterygostimal angles of anterior carapace prolonged to a point.......... *A. moluccensis* de Haan.
a^2. Infraorbital and pterygostimal angles of anterior carapace not long and pointed .... *A. serrata* Spence Bate.

ATYA MOLUCCENSIS de Haan.

Atya moluccensis de Haan, Fauna Japonica, Crustacea (1849) 184–186, pl. 21; Miers, Ann. & Mag. Nat. Hist. (V) 5 (1880) 42, pl. 15, figs. 3 and 4; de Man, Zool. Ergeb. (1892) 357, pl. 21, fig. 20; Ortman, Denk. Ges. Jena 8 (1894) 1–80, pls. 1–13; Proc. Acad. Nat. Sci. Phila. (1895) 408; de Man, Abh. Senck. Naturf. Ges. 138 (1904) 137.

Atya armata Milne-Edwards, Ann. Soc. Ent. de France (1864) 149, pl. 3, fig. 3; von Martens, Arch. Naturg. Jahrg. 47 (1868) 47, pl. 1, fig. 6.

Atya gustavi Ortman, Zool. Jahrb. Syst. 5 (1890) 467, pl. 36, figs. a, b, c.

Atya dentirostris Thallwitz, Abh. Ber. K. Zool. Anthr. ethn. Mus. Dresden (1891) 26, fig. 7.

Rostrum short, narrow, slenderly excavated at broad side of dorsal part and armed with numerous little teeth on ventral keel. Infraorbital and pterygostimal angles prolonged to a point. "Immobile" and "mobile" fingers of first and second peræopods alike in shape and size. Excavation of distal borders of carpus crescent-shaped.

Three adult specimens, 35 to 39 millimeters long.

NEGROS, Oriental Negros Province, Dumaguete River, March 8, 1922.

ATYA SERRATA Spence Bate. Plate 1, figs. 1 to 4.

Atya serrata Spence Bate, Challenger Rept. Zool. 24 (1888) 669, pl. 119, fig. 2; Ortman, Proc. Acad. Nat. Sci. Phila. (1895) 410; Bouvier, C. R. Acad. Sci. 138 (1904) 446; Bordage, C. R. Acad. Sci. 147 (1908) 1418, fig. 1; 148 (1909) 47; Calman, Quart. Journ. Micr. Sci. 55 (1910) 792; Bouvier, C. R. Acad. Sci. 152 (1911) 1822; 154 (1912) 692, figs. 4, 6, 7; Trans. Linn. Soc. London (II) 15 (1913) 460; C. R. Acad. Sci. 159 (1914) 700; Bouvier and d'Emmeres de Charmoy, C. R. Acad. Sci. 169 (1919) 317.

Ortmania alluaudi mutation *serrata* Bouvier, Bull. Scient. de Fr. et Belg. 39 (1905) 106, 115, fig. 19.

Atya brevirostris de Man, Zool. Ergeb. 2 (1892) 360, pl. 21, fig. 21; Ortman, Denk. Ges. Jena 8 (1894) 10; Ortman, Proc. Acad. Nat. Sci. Phila. (1895) 409; Schenkel, Verh. Naturf. Ges. Basel 13 (1902) 500, fig. 6; Bouvier, Bull. du Mus. (1904) 137.

Atya breverostris var. *de mani* Nobili, Ann. Mus. Civ. dei Storia Nat. Genova (II) 20 (1900) 475.

Atyoida tahitensis Stimpson, Proc. Acad. Nat. Sci. Phila. (1860) 97.

Infraorbital and pterygostimal angles of anterior part of carapace very short and pointed. Short rostrum not extending beyond second segment of antennular peduncle, curved downwards, ventrally forming a keel. Formula of rostral teeth $\frac{0}{5}$. "Immobile" and "mobile" fingers alike in shape and size in both first and second peræopods. Excavations of carpus of their distal borders, crescent-shaped. Apex of telson semicircular, possessing two externolateral spines and two internolateral spines.

Several specimens, 18 to 29 millimeters long.

LUZON, Ilocos Norte Province, Laoag River, February 5, 1934.

Genus CARIDINA Milne-Edwards

Caridina Milne-Edwards, Histoire naturelle des Crustaces 2 (1837).

Chelæ not very variable; dactylus or "movable finger" opposed to "immobile finger" or propodus; carpus of first pair short and broad, its distal margin more or less concave; propodus articulating with lower corner of carpus; carpus of second pair more or less elongated and slender; propodus articulating with its distal end.

Key to the known species of Caridina in the Philippines.

a^1. Rostrum long, curving upward towards tip; end bifid or trifid.

b^1. Number of teeth of upper and lower borders of rostrum $\frac{19}{16}$.

C. gracillima Lanchester.

b^2. Number of teeth of upper and lower borders of rostrum varying between $\frac{6-9}{17-27}$ .... *C. gracilirostris* de Man.

b^3. Number of teeth of upper and lower borders of rostrum varying from $\frac{13-24}{11-16}$ .... *C. modigliani* Nobili.

b^4. Number of teeth of upper and lower borders of rostrum varying from $\frac{11-23}{18-19}$ .... *C. brevicarpalis* var. *endehensis* de Man.

a^2. Rostrum short, not extending beyond antennal scale.

b^1. Number of teeth of upper and lower border of rostrum $\frac{21}{13}$; end trifid........ *C. nilotica* var. *endehensis* de Man.

b^2. Number of teeth of upper and lower borders of rostrum varying from $\frac{15-19}{2-6}$ .... *C. lævis* Heller.

CARDINA GRACILLIMA Lanchester. Plate 1, figs. 5 to 10.

Caridina gracillima Lanchester, Proc. Zool. Soc. London (1901) 560–563, pl. 34, fig. 1; Bouvier, Bull. Scient. de Fr. et Belg. 39 (1905) 72; C. R. Acad. Sci. 154 (1912) 918; Trans. Linn. Soc. London (II) 15 (1913) 463; Kemp, Mem. Asiat. Soc. Bengal 6 (1918) 285.

Rostral formula $\frac{19}{15}$; 19 teeth present on upper edge; lower edge bearing 15 teeth. Rostrum long, curving upwardly beyond antennal scale. Toothed part of upper edge, one-half less than total length. Carpus of first leg, twice as long as broad; that of second $4\frac{3}{4}$ times as long as broad. Dactylus of third pair with 10 spines; that of fifth pair, 60 spines. Uropods each with 12 spines.

A single female specimen, 34 millimeters long.

LUZON, Ilocos Norte Province, Laoag, Caaoacan River, August 14, 1933.

CARIDINA GRACILIROSTRIS de Man. Plate 2, figs. 11 to 17.

Caridina gracilirostris de Man, Zool. Ergeb. (1892) 399, pl. 25, fig 31; Zool. Jahrb, Syst. 9 (1897) 726; Nobili, Ann. Mus. Civ. St. Nat. Genova II 20 (1900) 477; J. Roux, Revue suisse de Zool. 12 (1804) 555; Bouvier, Bull. Scient. de Fr. et Belg. 39 (1905) 72; Trans. Linn. Soc. London II 15 (1913) 463; Kemp, Mem. Asiat. Soc. Bengal 6 (1818) 282.

Rostrum very long, extending beyond antennal scale. Tooth formula $\frac{(6-9)\pm 1}{17-27}$; upper edge armed with 6 to 9 teeth, two of them on carapace, in addition to a subapical tooth; lower edge with from 17 to 27 teeth. Toothed part of upper edge one-fourth less than length of unarmed part.

TABLE 1.—*Length and rostral formula of young Caridina gracilirostris de Man.*

Specimen—	Length.	Rostral formula.	Specimen—	Length.	Rostral formula.
	mm.			*mm.*	
1	25	$\frac{8+1}{19}$	11	25	$\frac{8+1}{21}$
2	24	$\frac{8+1}{20}$	12	27	$\frac{7+1}{21}$
3	23	$\frac{8+1}{19}$	13	20	$\frac{8+1}{25}$
4	22	$\frac{8+1}{20}$	14	24	$\frac{7+1}{20}$
5	22	$\frac{7+1}{17}$	15	25	$\frac{8+1}{17}$
6	21	$\frac{7+1}{21}$	16	21	$\frac{8+1}{21}$
7	22	$\frac{8+1}{23}$	17	22	$\frac{9+1}{27}$
8	20	$\frac{8+1}{21}$	18	22	$\frac{7+1}{27}$
9	21	$\frac{7+1}{21}$	19	21	$\frac{8+1}{21}$
10	20	$\frac{6+1}{19}$			

Carpus of first leg $1\frac{3}{4}$ times as long as broad. Dactylus of third pair with 12 spines; that of fifth pair, 50 spines. Terminal joints of third maxilliped with 17 spines. Uropods each with 9 spines.

Nineteen young specimens, 20 to 37 millimeters long (Table 1).

LUZON, Laguna de Bay, November, 1929.

CARIDINA NILOTICA var. BRACHYDACTYLA de Man. Plate 2, fig. 18.

Caridina wyckii de Man, Zool. Ergeb. (1892) 386–393, pl. 24, fig. 29, cc, dd, f, g, i, ii, k.

Caridina wyckii var. *paucipara* Bouvier, Bull. Scient. de Fr. et Belg. 39 (1905) 79.

Caridina nilotica var. *brachydactyla* de Man, Rec. Ind. Mus. 2 (1908) 269, pl. 20, fig. 8.

Caridina brachydactyla Bouvier, Trans. Linn. Soc. London II 15 (1913) 463.

Caridina brachydactyla subsp. *peninsularis* Kemp, Mem. Asiat. Soc. Bengal 6 (1918) 270, fig. 10.

Rostral formula $\frac{31}{13}$; 31 teeth present on almost entire length of upper edge; 5 teeth on carapace; that of lower edge with 13

teeth; its end trifid. Rostrum short, extending a little beyond antennal scale.

Fingers of first pair 2 to 2.5 times as long as palm. Carpus of second pair of legs very slender; 6 times as long as broad distally.

Eggs very numerous and small, 0.39 to 0.44 millimeter long and 0.22 to 0.25 millimeter wide.

A single sexually mature specimen, 27 millimeters long.

LUZON, Ilocos Norte Province, Laoag, Caaoacan River, August 14, 1933.

CARIDINA MODIGLIANI Nobili. Plate 2, figs. 19 to 24.

Caridina modigliani Nobili, Ann. Mus. Civ. Stor. Nat. Genova 20 (1900) 477; Bouvier, Bull. Scient. de Fr. et Belg. 39 (1905) 72.

Rostrum slender, curving upwardly towards the tip; very long, without spines on almost half of its distal length. Rostral formula $\frac{(13\text{–}24) \pm 2\text{–}3}{11\text{–}16}$; 13 to 24 teeth on the upper margin of the rostrum, 2 of them on the carapace; that of the lower margin with 11 to 16 teeth; its end bifid or trifid.

Carpus of the first peræopod, $1\frac{2}{3}$ times as long as broad; that of the second $5\frac{1}{5}$ times as long as broad.

Forty-one adult specimens, 23 to 34 millimeters long (Table 2).

LUZON, Ilocos Norte Province, Laoag, Laoag River.

CARIDINA BREVICARPALIS var. ENDEHENSIS de Man. Plate 2, fig. 25.

Caridina brevicarpalis var. *endehensis* de Man, Zool. Niederlandisch Ost. Indien (1892) 399, pl. 24, figs. 30c and 30e.

Rostral formula of two specimens $\frac{11}{18}$ and $\frac{23}{19}$, approaching rostral formula of $\frac{11\text{–}20}{14\text{–}20}$ given by de Man. Rostrum long, extending beyond antennal scale.

Four mature females, 25 to 29 millimeters long.

LUZON, Batangas Province, Pancipit River, April 19, 1934.

CARIDINA LÆVIS Heller. Plate 3, figs. 26 to 32.

Caridina lævis Heller, Verh. Zool. bot. Ges. Wien. 12 (1862) 411; de Man, Zool. Ergeb. (1892) 376, pl. 22, fig. 27; de Man, Rec. Ind. Mus. 2 (1908) 253, pl. 20; Ortman, Proc. Acad. Nat. Sci. Phila. (1895) 404; Bouvier, Bull. du Mus. (1904) 131; Bouvier, Trans. Linn. Soc. London II 15 (1913) 464; Kemp, Mem. Asiat. Soc. Bengal 6 (1819) 289.

Rostral formula $\frac{15\text{–}19}{2\text{–}6}$; upper margin of rostrum with 15 to 19 teeth, 2 to 5 located on carapace; lower margin with from 2 to 6 teeth; rostrum short, not extending beyond antennal scale.

TABLE 2.—*Length and rostral formula of female Caridina modigliani Nobili.*

Specimen—	Length.	Rostral formula.	Specimen—	Length.	Rostral formula.
	mm.			*mm.*	
1	31	$\frac{19+2}{15}$	22	29	$\frac{21+2}{18}$
2	28	$\frac{17+2}{14}$	23	32	$\frac{15+2}{12}$
3	25	$\frac{16+2}{15}$	24	29	$\frac{17+2}{15}$
4	27	$\frac{18+2}{13}$	25	30	$\frac{17+2}{15}$
5	30	$\frac{14+2}{15}$	26	24	$\frac{15+2}{15}$
6	29	$\frac{14+2}{18}$	27	25	$\frac{19+2}{16}$
7	23	$\frac{20+2}{16}$	28	29	$\frac{13+2}{13}$
8	27	$\frac{18+2}{16}$	29	28	$\frac{20+2}{14}$
9	31	$\frac{19+2}{16}$	30	26	$\frac{22+2}{15}$
10	31	$\frac{21+2}{17}$	31	27	$\frac{17+2}{15}$
11	32	$\frac{17+2}{19}$	32	30	$\frac{19+2}{15}$
12	26	$\frac{18+2}{14}$	33	32	$\frac{17+2}{14}$
13	27	$\frac{17+2}{14}$	34	31	$\frac{22+2}{17}$
14	27	$\frac{16+2}{14}$	35	33	$\frac{17+2}{20}$
15	26	$\frac{18+2}{14}$	36	29	$\frac{17+2}{15}$
16	26	$\frac{14+2}{11}$	37	27	$\frac{18+3}{12}$
17	27	$\frac{11+2}{16}$	38	26	$\frac{12+3}{17}$
18	23	$\frac{15+2}{12}$	39	25	$\frac{17+3}{15}$
19	29	$\frac{16+2}{15}$	40	34	$\frac{18+3}{16}$
20	26	$\frac{14+2}{14}$	41	27	$\frac{19+3}{14}$
21	28	$\frac{17+2}{15}$			

Fifteen young specimens, 15 to 19 millimeters long (Table 3). LUZON, Albay Province, Pulangue Lake, January 26, 1926.

TABLE 3.—*Length and rostral formula of Caridina lævis Heller.*

Specimen—	Length.	Rostral formula.	Specimen—	Length.	Rostral formula.
	mm.			*mm.*	
1	16	$\frac{18}{6}$	9	18	$\frac{19}{6}$
2	19	$\frac{18}{6}$	10	15	$\frac{19}{5}$
3	18	$\frac{17}{4}$	11	17	$\frac{16}{6}$
4	18	$\frac{15}{4}$	12	16	$\frac{16}{6}$
5	17	$\frac{19}{5}$	13	18	$\frac{15}{4}$
6	16	$\frac{17}{5}$	14	17	$\frac{18}{2}$
7	19	$\frac{17}{5}$	15	16	$\frac{17}{4}$
8	18	$\frac{17}{6}$			

Genus ORTMANIA Rathbun

Ortmania Rathbun, U. S. Fish. Comm. 2 (1910) 120.

Carpus of first pair of legs similar to that of second pair, being short and broad, distal margin excavated and articulating with propodus of lower corner. Some species of *Ortmania* have second carpus similar to that in *Caridina*, by being somewhat longer than the first; excavation of distal margin shallow. Some with carpus nearly similar in the two pairs, and deeply excavated to assume a crescentic form as in *Atya*. In some species chelæ quite similar to those of *Caridina*, in others "palm" much shortened, with articulation of "movable finger" carried backwards towards base of propodus.

ORTMANIA sp. (?). Plate 3, figs. 33 to 40.

Rostrum short, not extending beyond antennal scale. Rostral toothing $\frac{0}{3}$; no teeth on upper edge, and 3 teeth at lower edge. Shape of rostrum similar to that of *O. mexicana* de Saussure. Segments of antennular peduncle with numerous spines.

First peræopod similar in shape to that of *Atya*. Dactylus of third pair of legs with 4 spines; that of fifth pair with 20 spines. Apex of telson similar to that of *O. alluaudi* Bouvier. One of the uropods with 15 spines.

A single young specimen, 14 millimeters long.

LUZON, Ilocos Norte Province, Laoag, Caaoacan River, August 14, 1933.

This specimen is probably a variety of *O. mexicana* de Saussure, if the character of the rostrum is taken as a basis for classification, but due to lack of material I hesitate to assign it to *O. mexicana*.

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ILLUSTRATIONS

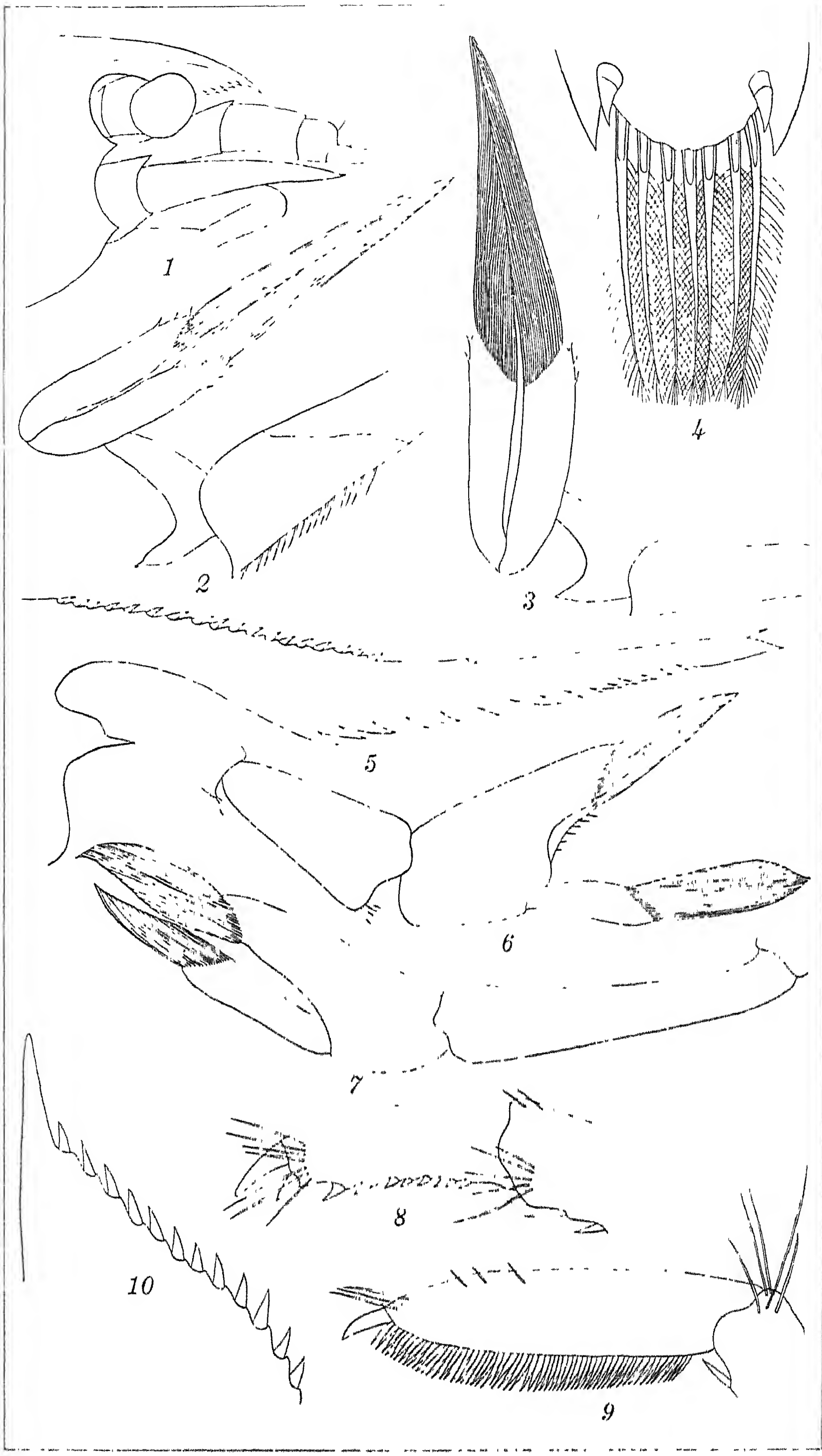

PLATE 1.

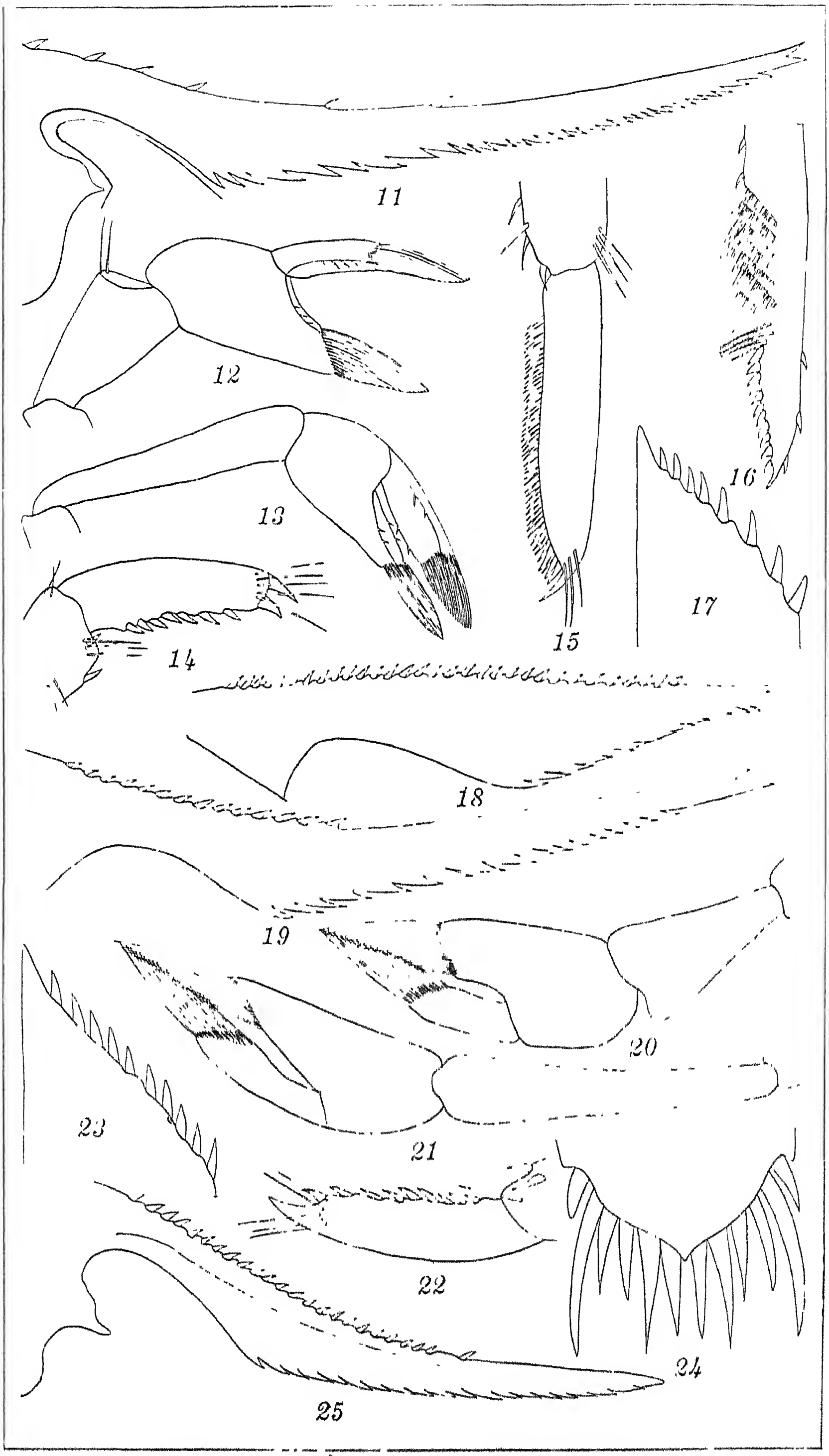

PLATE 2.

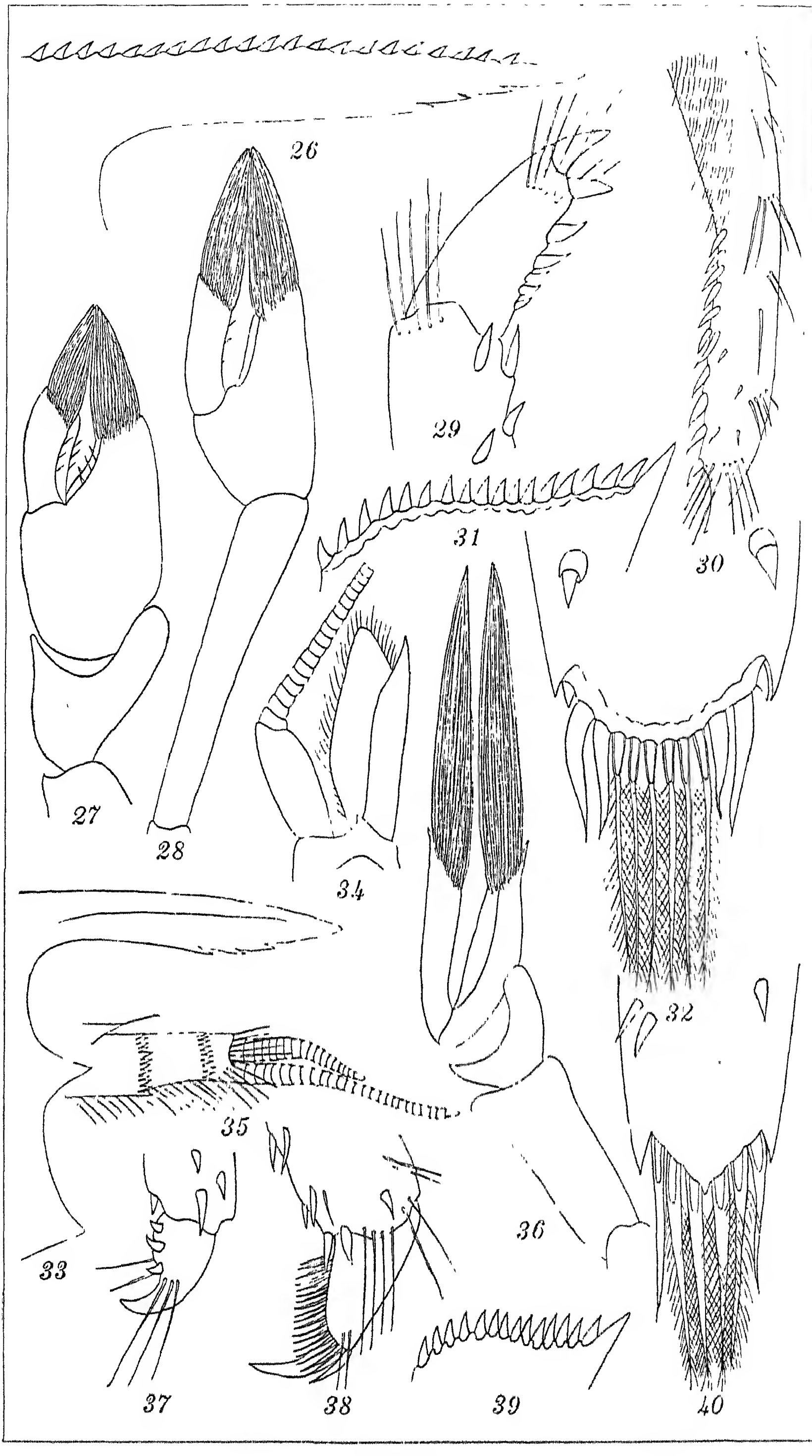

PLATE 3.

THE DEVELOPMENT OF THE HOMOCERCAL CAUDAL OF THE BLUE PERCH, TÆNIOTOCA LATERALIS AGASSIZ [1]

By Guillermo J. Blanco

Of the Fish and Game Administration, Bureau of Science, Manila

ONE PLATE

The caudal fin of fishes is built upon the modification of the protocercal embryonic fin. Agassiz, Heckel, Huxley, Kölliker, Ryder, and many others have shown that the structure of the homocercal fin of bony fishes is a modified structure of the heterocercal caudal fin.

The structure of the acanthopterygian caudal fin in six genera was studied by Whitehouse (1910). He found that the structure of the tail fin may vary considerably in the same suborder. Apparently no one has studied the development of the caudal fin in the viviparous perches, hence the descriptions of the caudal fin of the blue perch are here given.

The protocercal caudal of a larva 3 mm long (Plate 1, fig. 1), is an extension of the notochord, the narrow dorsal fin is not continuous with the ventral fin fold.

The larva when 7 mm long (Plate 1, fig. 2) has an axial lobe, *axl*, that is narrow dorsally and wide ventrally with reference to the notochord, which curves slightly downwards.

The larva when 12 mm long (Plate 1, fig. 3) has a caudal fin heterocercal in general form. The notochord has its characteristic vacuolated structure and is turned upwards in the axial lobe. There are traces of six cartilaginous areas, *a*, *b*, *c*, *d*, *e*, and *f*, the anlage of the hypurals. Cartilaginous areas *d* and *e* have a common base, while areas *a*, *b*, *c*, and *f* are separated. To each cartilaginous hypural one or more caudal rays are attached for the support of the enlarging membrane of the caudal fin.

The caudal fin of a larva 14 mm long (Plate 1 fig. 4) has the notochord turned upwards toward the axial lobe. The beginnings of the neural spines, *ep*, first appear above the notochord.

[1] This work was done at the University of Washington as a partial fulfillment of the requirements for the degree of Master of Science.

The cartilaginous hypurals are still asymmetrically placed, as in Plate 1, fig. 3. The caudal fin has grown larger and most of the caudal rays arising at the distal end of the hypurals now lie more or less in line with the chordal axis.

The internal parts of the caudal fin of a larva 16 mm long (Plate 1, fig. 5) are still asymmetrically placed. Areas *a* and *d* have assumed a triangular shape; areas *b* and *c* are now parallel; *c* has its bases fused with those of *d* and *e*, so that all these hypurals now have a common base, while areas *a*, *b*, and *f* are separate. An additional cartilaginous hypural, *g*, is in evidence at this stage. The last two neural spines are also distinct.

Plate 1, fig. 6, shows a caudal fin of a larger larva. The axial lobe which was evident in smaller fishes has disappeared in the former stages.

The caudal fin of a larva 21 mm long (Plate 1, fig. 7) shows a marked shortening and thickening of the notochord, the hindmost portion of which becomes the urostyle. The vertebral segments of the caudal fin are still indistinct. Hypurals *a*, *b*, *f*, and *g* are separated, *b*, *c*, *d*, and *e* have fused bases. Cartilaginous areas *a* to *g* are in the process of ossification with the ventral part of the chordal axis. The dorsal caudal radials, *dcr*, are between the urostyle and the last neural spine. The caudal fin at this stage is externally symmetrical and fan-shaped, but internally it is asymmetrical.

In a larva 41 mm long (fig. 8) hypurals *a*, *b*, *c*, and *d* are joined to the urostyle. Hypural *e* is connected with the last vertebra and *g* with the penultimate vertebra. The three dorsal caudal radials are inserted deeper, and between the last neural spine and the urostyle. The segmented dermotrichia, *der*, are now well developed externally and overlap the edge of the three dorsal caudal radials, *dcr*, the hypurals, *hy*.

Plate 1, fig. 9, shows the caudal fin of a young perch, 51 mm long, in which the third dorsal caudal ray is inserted between the urostyle and the first hypural plate.

Plate 1, fig. 10, is the homocercal caudal of an adult female specimen 21 cm long. It has a much reduced urostyle. The last dorsal caudal ray is distinctly separated from the tip of the urostyle.

SUMMARY

1. *Tæniotoca lateralis* Agassiz is a viviparous blue perch found in shallow waters along the entire western coast of North America, between San Diego, United States, and Vancouver Island, Canada.

2. The developmental stages of the homocercal caudal fin of the blue perch are here described in detail for the first time.

3. The significant changes of the embryonic caudal fin of a larva 3 mm long to the homocercal caudal fin of the adult 21 cm long are as follows:

(*a*) The presence of an axial lobe in a 7-mm larva represents a characteristic feature of its embryonic development.

(*b*) The change of the protocercal caudal fin to heterocercal caudal fin in a larva 12 mm long, and the appearance of an anlage of six asymmetrical cartilaginous hypurals, each having one or more caudal rays.

(*c*) A larva 14 mm long has the beginnings of the neural spines which develop above the upturned notochord.

(*d*) The caudal fin of a larva 16 mm long has seven hypurals, the first four parallel to each other; the third, fourth, and fifth have a common base.

(*e*) The axial lobe at this stage is evidently lost.

(*f*) In a larva 21 mm long the urostyle is present as the result of the shortening and thickening of the posterior part of the notochord. Three dorsal caudal radials are at this stage inserted between the urostyle and the last neural spine.

(*g*) A larva 41 mm long has apparently hypurals which are joined to the penultimate vertebra, while the segmented dermotrichia are at this stage well developed.

(*h*) The caudal fin of a young perch 51 mm long shows a slight difference from that of an adult homocercal caudal fin of a specimen 21 cm long. The urostyle is much reduced in the adult, and the dorsal caudal rays are distinctly separated from the tip of the urostyle.

DEFINITION OF TERMS

DERMOTRICHIA. A caudal fin ray.

PROTOCERCAL. A protocercal caudal fin is a primitive type of a caudal, externally and internally symmetrical, indicating that the tail has not undergone any modification from the original form.

HETEROCERCAL. A heterocercal caudal is one in which an upbending of the vertebræ has taken place, and in which the hypaxial and epaxial elements and the caudal lobe of the fin are asymmetrically placed.

HOMOCERCAL. A homocercal caudal fin is a specialized heterocercal caudal, externally symmetrical; the majority of the fin rays are supported externally by the hypaxial elements; a urostyle, present in the larval stage, persists for a time in the adult.

UROSTYLE. The urostyle is an elongated conelike termination of the vertebral column, representing the fusion of several last vertebræ.

HYPAXIAL. Morphological structures ventral to the chordal axis.

EPAXIAL. Morphological structures dorsal to the chordal axis.

HYPURAL. Any hypaxial structure connected directly with the chordal axis to which one or more fin rays are attached.

EPURAL. Any epaxial element having direct connection with the chordal axis to which one or more fin rays are attached on its distal end.

RADIAL. Synonymous to "interspinous bone" and "somatid;" a daggerlike bone having no direct connection with the vertebral column; it supports one or more fin rays distally.

LAST VERTEBRAL SEGMENT. This term refers to the last centrum and the urostyle, if such structures exist; the last centrum is never perfect; it is usually conelike with the apex directed posterodorsally.

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ILLUSTRATIONS

ABBREVIATIONS USED

axl, Axial lobe.
a, b, c, d, e, f, g, Cartilaginous hypural areas.
cent, Centrum.
der, Dermotrichia.
dcr, Dorsal caudal radial.
ep, Epural.
f, Permanent caudal fin.
fn, Fin fold.
hs, Hæmal spine.
hy, Hypural.
lv, Last vertebra.
ns, Neural spine.
nt, Notochord.
ur, Urostyle.

PLATE 1. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 1. A larva 3 mm long.
2. Caudal of a larva 7 mm long.
3. Caudal of a larva 12 mm long.
4. Caudal of a larva 14 mm long.
FIGS. 5 and 6. Caudal of a larva 16 mm long.
FIG. 7. Caudal of a larva 21 mm long.
8. Caudal of a larva 41 mm long.
9. Caudal of a young perch 55 mm long.
10. Adult homocercal caudal of a female 21 cm long.

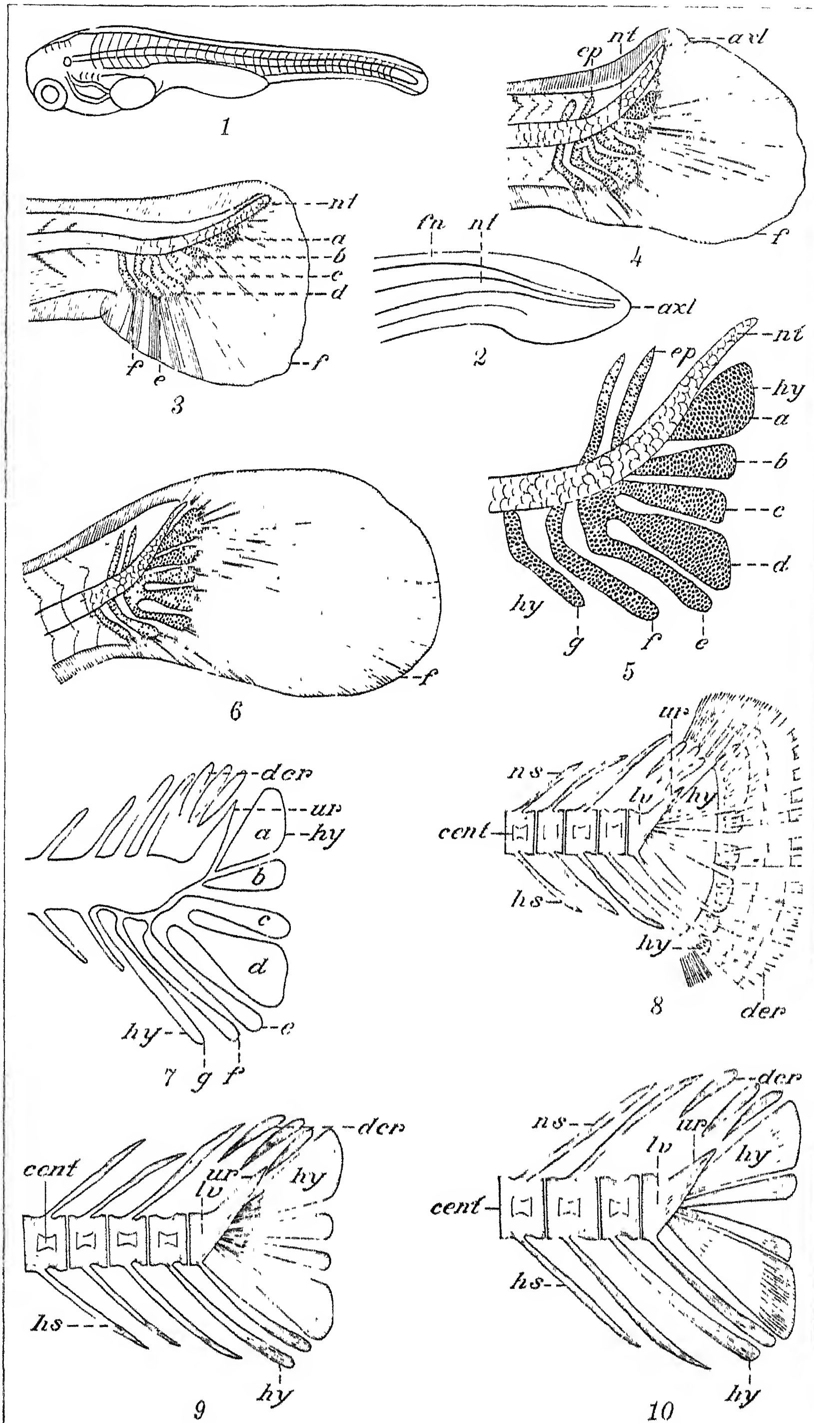
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PLATE 1.

PHILIPPINE MELIOLINEÆ [1]

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and

E. F. Roldan

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THREE TEXT FIGURES

The purpose of the present article is to record the Meliolineæ collected by the senior author during his stay of eight months in the Philippines as Charles Fuller Baker Memorial Professor of Plant Pathology (1930–1931) that may be new, or upon hosts not previously recorded, or otherwise of especial interest. The arrangement is that of the senior author's monograph of the Meliolineæ.[2]

Specimens of all fungi noted in this article have been deposited in the herbarium of the University of Illinois, Urbana, Illinois; the herbarium of the Bureau of Science, Manila, Philippine Islands; and the herbarium of the College of Agriculture, Los Baños, Laguna, Philippine Islands. In addition, when material was of a quantity sufficient to warrant it, duplicate specimens were placed in several leading mycological centers in America. We are much indebted for determinations of hosts to Ranger Mamerto Sulit, of the School of Forestry, Los Baños; to Dr. Eduardo Quisumbing, botanist of the National Museum Division of the Bureau of Science; and to Dr. E. D. Merrill, director-in-chief of the New York Botanical Garden.

[1] Contribution No. 977 from the experiment station of the College of Agriculture, Los Baños, Laguna, Philippine Islands, and of the Department of Botany of the University of Illinois, Urbana, Illinois. Published with the approval of the dean of the College of Agriculture.

[2] Ann. Mycol. 25 (1927) 405; 26 (1928) 165.

Genus AMAZONIA Theissen

AMAZONIA PEREGRINA (Sydow) Sydow.

Group number 3101.4230.

On Myrsinaceæ: *Maesa laxa*. This species is widely distributed in Luzon, collections having been made in Benguet, La Union, Ilocos Sur, Bontoc, and Laguna.

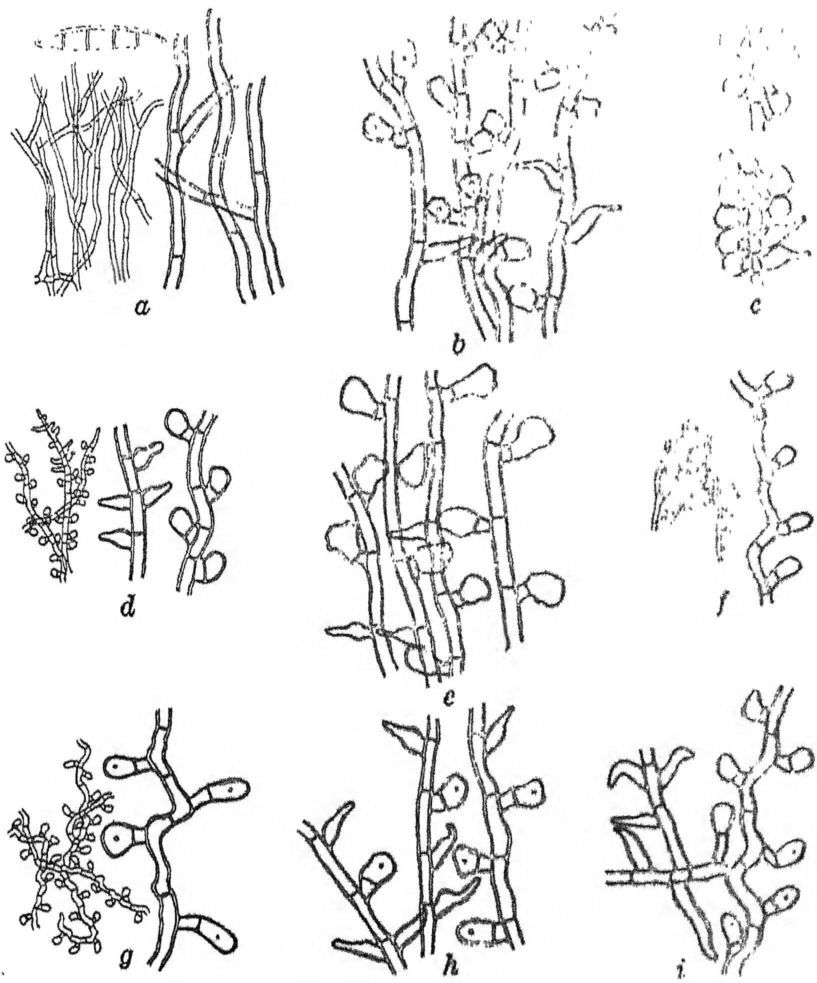

FIG. 1.

Genus MELIOLINA Sydow

MELIOLINA SAURAUIAE sp. nov. Fig. 1, a.

Colony epiphyllous, 3 to 15 mm in diameter, black, diffuse, indefinite. Mycelium 6 μ thick, crooked, smooth, branching at very acute angle. Spot none. Capitate hyphopodia and mucronate hyphopodia none.

Perithecial setæ and mycelial setæ none. Perithecia globose, 130 to 190 μ in diameter, very rough, surfaced with conic projections about 10 to 30 μ high. Asci evanescent, 2- to 4-spored. Spores 4-septate, long and narrow, 57 to 70 by 13 μ, end cells conic.

Group number 3100.6220.

On Dilleniaceæ: *Saurauia latibraclea.* Naguilian Road, Benguet, Luzon, January 5, 1931, No. 1480.

This exceedingly interesting species falls within the section of the genus having no setæ, which section has only five species and three of these are recorded as parasitic upon other Meliolineæ. Of the two reported on phanerogams, one has 3-septate spores, thus leaving only one *Meliolina* that has the formula 3100; namely, *M. megalospora* (Speg.) Stevens, on *Jodina.* Comparison of the senior author's specimen with the type of this shows very distinct differences in colony and mycelial character, the present species having a thinner mycelium and a larger, looser colony. It is interesting that another *Meliolina, M. malacensis* (Sacc.) Stevens, is described on the Dilleniaceæ from Singapore; this one, however, has long and much-branched setæ.

MELIOLINA ARBORESCENS (Sydow) Sydow.

Group number 2140.5342.

In the senior author's monograph of the Meliolineæ, page 419, it was suggested that though *M. yatesii* was originally described by Sydow as being on *Viburnum,* in reality the host may be one of the Myrtaceæ. Dr. E. Quisumbing has definitely determined for us that the host of the type material is not a *Viburnum* but a *Eugenia.* Therefore, the synonymy suggested by one of us in the monograph is confirmed.

Genus IRENE Theissen and Sydow

IRENE PAPILLIFERA Sydow.

Group number 3201.4320.

On Dilleniaceæ: *Saurauia elegans.* Three collections were made on the road from Baguio to Naguilian, Mountain Province, Luzon.

Genus IRENOPSIS Stevens

IRENOPSIS BENGUETENSIS sp. nov. Fig. 1, b.

Colony 2 to 20 mm in diameter, amphigenous, black, indefinite. Mycelium 6 to 7 μ thick, black, smooth, slightly crooked. Spot none. Capitate hyphopodia alternate, not crowded, usual-

ly about 30 μ apart, often less close. Stalk cell short, 4 to 6 μ, head cell pyriform, regular or slightly irregular. Mucronate hyphopodia ampulliform, alternate or opposite.

Perithecial setæ arising from the lower half of the perithecium, 70 to 105 μ long, 10 μ thick, simple, black, straight or slightly curved. Mycelial setæ none. Perithecia globose, smooth, 100 to 115 μ in diameter. Asci evanescent. Spores 4-septate, 40 by 13 to 15 μ.

Group number 3401.3220.

On Moraceæ: *Ficus variegata.* Naguilian Road, Benguet, Luzon, January 5, 1931, Nos. 1566 (type) and 1528.

No species of *Irenopsis* has heretofore been described on *Ficus* or any other genus of the Moraceæ. This species is very clearly characterized by the entire absence of mycelial setæ and the presence of a few short black setæ arising from the base of the perithecium.

IRENOPSIS CORONATA (Speg.) Stevens var. PHILIPPINENSIS var. nov. Fig. 3, 1.

Colony very minute, almost invisible. Mycelium dark, smooth, 6 to 7 μ thick. Spot none. Capitate hyphopodia alternate, in some colonies few, in others more abundant. Stalk cell short, 3 to 4 μ, head cell pyriform, regular. Mucronate hyphopodia ampulliform, often very abundant, present almost to the exclusion of the capitate hyphopodia.

Perithecial setæ few, 6 to 8, growing from the lower part of the perithecium, 100 to 130 μ long, not uncinate. Mycelial setæ none. Perithecia globose, black, smooth, except for a few setæ arising from near the base. Asci evanescent. Spores 4-septate.

Group number 3401.4220.

On Tiliaceæ: *Columbia serratifolia.* Agricultural College, Laguna Province, Luzon, September 10, 1930, No. 510.

The irregular arrangement of the hyphopodia is striking. Sometimes the capitate hyphopodia are abundant and regularly placed; at other times they are very irregularly placed, giving the mycelium almost the appearance of a branch without hyphopodia. In some colonies the capitate hyphopodia are exceedingly rare, while the mucronate hyphopodia are very common.

This variety differs from other varieties of this species in its variable ratio between mucronate and capitate hyphopodia and in the shape of its capitate hyphopodia, which are pyriform while in the other varieties the capitate hyphopodia are shorter,

almost globose. It is striking to note that the only Meliolineæ described on the Tiliaceæ are *Irenopsis coronata* and three varieties of this fungus. Two species of *Irenina* that were originally described on other families are said to be found on Tiliaceæ, but they may rest upon erroneous determinations. Though only this one species and its four varieties are known upon the Tiliaceæ, they are widely distributed, being recorded from Paraguay, Africa, Brazil, Argentine, Porto Rico, Santo Domingo, and the Philippines.

IRENOPSIS CORONATA (Speg.) Stevens var. **TRIUMFETTAE** (Stevens) Stevens.

Group number 3401.4220.

On Tiliaceæ: *Triumfetta bartramia.*

Hyphæ of considerable length without hyphopodia frequently occur, especially within areas near the perithecia.

A *Meliola* on *Triumfetta* which has been reported from the Philippines as *M. arachnoidea* is probably this variety.

The remarkable agreement in the character of the colony on the leaf and the morphology of this fungus on *Triumfetta* from such widely separated parts of the world as Porto Rico, South Africa, and the Philippine Islands is noteworthy.

Genus IRENINA Stevens

IRENINA ACALYPHAE sp. nov. Fig. 1, c.

Colonies small, mostly less than 2 mm in diameter, amphigenous, densely black, circular. Mycelium 7 to 8 μ thick, densely crowded. Spot none. Capitate hyphopodia opposite, densely crowded, touching. Stalk cell short, 3 to 4 μ, head cell subglobose to subcubical. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ none. Perithecia globose, 130 to 145 μ in diameter, very rough with conic protuberances up to 30 μ high, though with no true larviform appendages. Asci evanescent. Spores 4-septate, 47 by 16 μ.

Group number 3102.4220.

On Euphorbiaceæ: *Acalypha.* Acop's, Benguet, Luzon, December 30, 1930, No. 1211.

Although five species of *Irenina* are recorded as upon the Euphorbiaceæ, none of them has opposite capitate hyphopodia. The extreme roughness of the perithecial wall suggests the genus *Irene,* but no actual vermiform appendages were found, nor is any species of *Irene* with opposite hyphopodia known on this host family. The formula is close to that of *Amazonia acalyphae,* but the perithecia here are free and globose and show no

kinship to *Amazonia.* The chief characteristic of the species is the very rough perithecium and the very dense character of the colony.

IRENINA RUBI sp. nov. Fig. 1, d.

Colony very small, nearly invisible, usually consisting of only a few mycelial strands. Mycelium 6 to 7 μ thick. Spot none. Capitate hyphopodia alternate, usually about 23 μ apart. Stalk cell short, 3 to 4 μ, head cell globose, regular. Mucronate hyphopodia ampulliform, 16 to 20 μ long.

Perithecial setæ none. Mycelial setæ none. Perithecia globose, smooth, 130 to 145 μ in diameter. Asci evanescent. Spores 4-septate, 33 to 36 by 14 μ.

Group number 3101.3220.

On Rosaceæ: *Rubus rosaefolius.* Naguilian Road, Benguet, Luzon, January 6, 1931, No. 1549 (type); Sariaya, Tayabas Province, Luzon, August 9, 1930, No. 193.

On *Rubus molucanus.* Mount Santo Tomas, Benguet, Luzon, December 31, 1930, No. 1361.

IRENINA RUBI var. **ANGULATA** var. nov. Fig. 1, e.

This variety is like the species except that the capitate hyphopodia have head cells that are irregular to angular and large, to 17 μ across.

On Rosaceæ: *Rubus molucanus.* Naguilian Road, Benguet, Luzon, January 6, 1931, No. 1461 (type).

Rubus rosaefolius, Naguilian Road, Benguet, Luzon, January 6, 1931, No. 1472.

These two forms of *Meliola,* each occurring on two species of *Rubus* in the same region of Luzon, are interesting. Sometimes either one or the other of the species is found alone upon a given collection. On other collections both varieties may occur side by side upon the same leaf. There is, however, no evidence of intergrading of the two forms; one has the small regular head cells, the other the large irregular ones.

The Meliolineæ upon Rosaceæ in the Philippines are especially interesting since of the five species previously described three had 3-septate spores and two had 4-septate spores. Moreover, the 3-septate species were of wide distribution, including the United States, South America, Japan, Porto Rico, Hawaii, and Africa, while the two 4-septate species were known only from the Argentine and Brazil. It appears, therefore, that the preponderant type upon Rosaceæ was that of

In the Philippines no species had heretofore been reported upon *Rubus*, doubtless due to their very minute, inconspicuous colonies. The species now found upon *Rubus* are all of the 4-septate type, none with 3-septate spores.

It may be possible that the Philippine Meliolineæ upon *Rubus* have comparatively recently acquired tenancy upon that host, coming perhaps from some other host, and that the present poorly developed colony may be due to the fact that they have not become as well adapted to their host as have the 3-septate forms, which have had much longer residence upon Rosaceæ.

IRENINA ANGUSTISPORA sp. nov. Fig. 1, f.

Colony 1 to 3 mm in diameter, thin, hypophyllous. Mycelium 4 to 5 μ thick, very crooked, often zigzag, smooth. Spot none. Capitate hyphopodia alternate or unilateral, usually from 13 to 35 μ apart. Stalk cell short, 3 to 4 μ, head cell subglobose, oblong or cuneiform. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ none. Perithecia globose, smooth, 146 to 175 μ, black, very rough with conic black projections about 16 μ high, which simulate but are not larviform appendages. Asci evanescent. Spores 4-septate, 33 by 7 to 9 μ.

Group number 3101.2120.

On Rubiaceæ: *Neonauclea* sp. Naguilian Road, Benguet, Luzon, January 7, 1931, No. 1620.

This species is chiefly characterized by its very rough perithecium, very crooked mycelium, and very narrow ascospores. It differs from all Ireninæ on the Rubiaceæ in these regards.

IRENINA ANGUSTISPORA Stevens var. LAEVIS var. nov. Fig. 1, g.

On Rubiaceæ: *Neonauclea*. Kennon Road, Benguet, Luzon, January 8, 1931; No. 1633.

This variety is like the species except that the perithecia are smooth.

IRENINA CALLICARPAE sp. nov.

Colony epiphyllous, of indefinite shape, not very dark, mycelium smooth, crooked, about 5 μ thick, anastomosing profusely, forming a network. Spot none. Capitate hyphopodia alternate, usually 33 to 50 μ apart. Stalk cell short, 4 to 11 μ long, head cell ovate to pyriform, regular. Mucronate hyphopodia ampulliform, pale, thin.

Perithecial setæ none. Mycelial setæ none. Perithecia globose, 150 μ in diameter, rough due to conical surface cells. Asci evanescent. Spores 4-septate, 36 by 17 μ.

Group number 3101.3220.

On Verbenaceæ: *Callicarpa magna*. Naguilian Road, Benguet, Luzon, January 6, 1931, No. 1468 (type); Santo Tomas, La Union Province, Luzon, December 31, 1930, No. 1291.

Of the five species of *Irenina* recorded as upon members of the Verbenaceæ and that have alternate capitate hyphopodia, only *I. glabroides* and *I. vitis* have spores as small as those in the present species, and each of these differs markedly in mycelial character, not anastomosing freely as is the case with the present species. The distinctive character of this species is the abundant anastomosis of the mycelium, making the colony into a distinct network.

IRENINA THUNBERGIAE sp. nov. Fig. 1, h.

Colony 1 to 4 mm in diameter, loose, epiphyllous. Mycelium 6 μ thick, crooked. Spot none. Capitate hyphopodia alternate, usually 16 to 26 μ apart, sometimes 70 μ. Stalk cell to 10 μ long, head cell large, angular, 16 μ. Mucronate hyphopodia ampulliform, scarce.

Perithecial setæ none. Mycelial setæ none. Perithecia globose, 145 to 160 μ, rough with conic protuberances, about 15 μ high. Asci evanescent. Spores 4-septate, 43 by 16 μ.

Group number 3101.4220.

On Acanthaceæ: *Thunbergia alata*. Kennon Road, Benguet, Luzon, January 8, 1931, No. 1642.

This in its larger, more irregular head cells, and its much less dense and larger colony shows no resemblance to *I. irregularis*.

IRENINA SANDORICI (Rehm) Stevens.

Group number 3101.2220.

On Meliaceæ: *Sandoricum koetjape*. Agricultural College, Laguna Province, and Quezon Forest Park, Tayabas Province, Luzon.

IRENINA SINUOSA sp. nov. Fig. 1, i.

Colony hypophyllous, thin, scattered, indefinite, to 2 cm in diameter. Mycelium very crooked, so as to give the appearance of anastomosing, thin, 3 to 4 μ. Spot none. Capitate hyphopodia alternate or unilateral, usually about 25 μ apart. Stalk cell short, 3 to 4 μ, standing out at right angles to the mycelium, head cell cylindrical or ovate. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ none. Perithecia globose, black, somewhat rough, 140 to 175 μ in diameter. Asci evanescent. Spores 4-septate, 50 to 57 by 17 μ.

Group number 3101.4220.

On Euphorbiaceæ: *Glochidion* sp. Balete Pass, Nueva Ecija Province, Luzon, January 9, 1931, No. 1744 (type).

This species does not have capitate hyphopodia close or globose as in *M. alchoreae,* nor very few as in *I. subapoda* and *I. verrucosa.* It differs from *I. alchorneae* in its crooked mycelium.

IRENINA SUBAPODA (Sydow) Stevens.

Group number 3101.3220.

On Euphorbiaceæ: *Mallotus philippinensis.* Balete Pass, Nueva Ecija Province, Luzon.

IRENINA UNCARIÆ (Rehm) Stevens.

Group number 3102.2220.

On Rubiaceæ: *Uncaria perrottetii.* Collections were made from Laguna, Benguet, and Tayabas Province, Luzon.

IRENINA COMBRETI Stevens.

Group number 3101.4220.

On Combretaceæ: *Quisqualis indica.* Santa Cruz, Laguna Province, Luzon.

None of the Meliolineæ has been reported before upon *Quisqualis.*

Genus MELIOLA Fries

GROUP 1. Spores 2- or 3-septate; formula ½ – – –. or 2 – – –. or ⅔ – – –.

MELIOLA PALAQUII sp. nov. Fig. 2, a.

Colony 4 to 6 mm in diameter, often coalescing, black, circular, amphigenous but mainly hypophyllous. Mycelium 6 μ thick, slightly crooked, black. Spot blanched. Capitate hyphopodia alternate, not crowded, 16 to 135 μ apart. Stalk cell long, to 13 μ, head cell large, to 23 μ, very irregular and angled. Mucronate hyphopodia ampulliform, thick, long.

Perithecial setæ none. Mycelial setæ about 200 μ long, 5 to 6 μ thick at base, tapering to 3 μ thick at apex, obtuse, mastigal. Perithecia sparse, globose, smooth, 145 to 175 μ in diameter. Asci evanescent. Spores 3-septate, 50 to 54 by 16 to 20 μ, the two central cells large, the end cells smaller and somewhat conical.

Group number 211.5221.

On Sapotaceæ: *Palaquium* sp. Mount Maquiling, Laguna Province, Luzon, January 18, 1931, No. 1900.

This beautiful species differs markedly in the very irregular head cells from all other species found upon the Sapotaceæ, also in having 3-septate spores and the long whiplike setæ. It is the only species known on this family with 3-septate spores.

GROUP 3. Formula 314–. or 313.

MELIOLA GANOPHYLLI sp. nov. Fig. 3, k.

Colony 1 to 3 mm in diameter, very black, very dense. Mycelium 6 to 7 μ thick, strands growing side by side so as to cover completely the subtending surface. Spot none. Capitate hyphopodia alternate, closely crowded. Stalk cell short, 3 to 4 μ, head cell globose. Mucronate hyphopodia ampulliform.

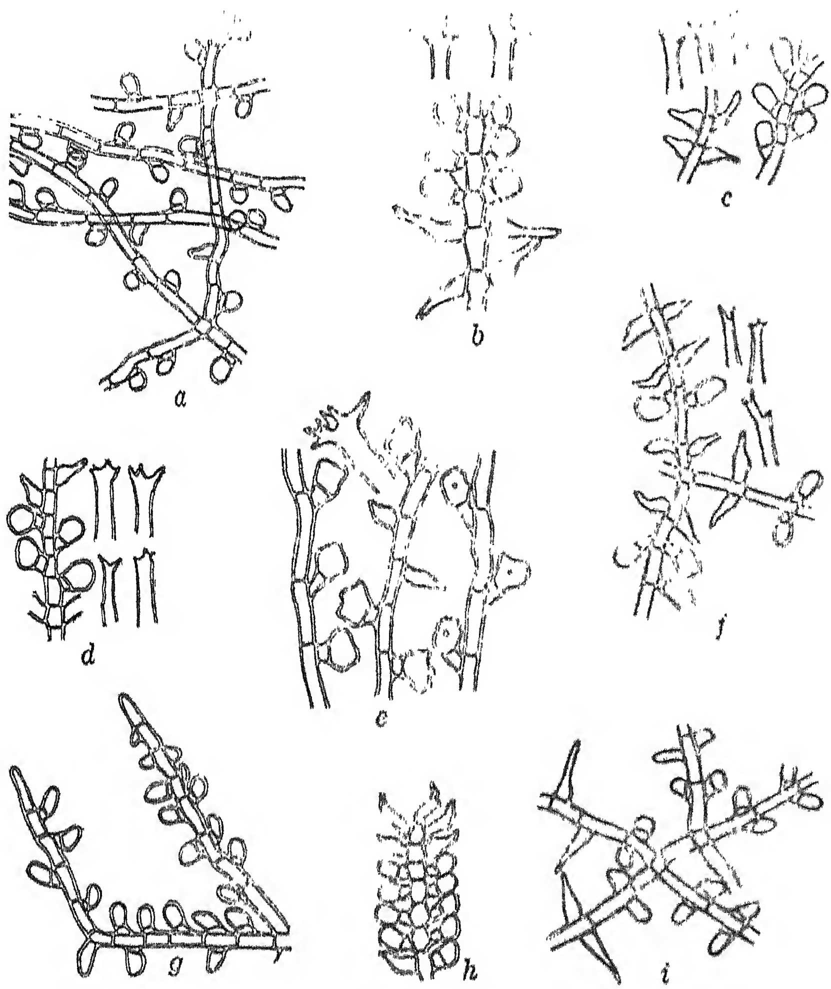

FIG. 2.

Perithecial setæ none. Mycelial setæ numerous, 190 to 300 μ long, 7 μ thick at base, apex bearing two, three, or four short, 2- to 6-μ teeth, or rarely twice branched, and primary branches 20 μ long. Perithecia globose, smooth, 145 to 160 μ in diameter. Asci evanescent. Spores 4-septate, 47 to 50 by 20 μ.

Group number 31¾–1.4221.

On Sapindaceæ: *Ganophyllum falcatum.* Kennon Road, Benguet, Luzon, January 8, 1931, No. 1671.

This species differs from *M. sapindacearum* in having no opposite capitate hyphopodia; from *M. sapindi,* which has larger and more irregular head cells and a less dense colony; it is close to *M. paulliniae* var. *dentata* but differs from it in head cells and in density of colony. No *Meliola* has heretofore been recorded upon this host genus.

MELIOLA PATENS Sydow.

Group number 3141.4231.

Collection was made at Balete Pass, Nueva Ecija Province, Luzon, on *Murraya paniculata.* It had not been before reported on this genus.

MELIOLA HETERODONTA Sydow.

Group number 31¾–1.3223.

This species was described by Sydow as on an unknown host.

The host of the type specimen was determined for us by Dr. E. Quisumbing as *Dracontomelum dao,* of the Anacardiaceæ.

MELIOLA MICROMELI sp. nov. Fig. 2, b.

Colony 1 to 3 mm in diameter, amphigenous, more often epiphyllous, black, very dense, crustose. Mycelium 6 μ thick, smooth, crooked. Spot pale, showing from both sides of the leaf. Capitate hyphopodia usually alternate, rarely opposite, densely crowded, usually less than 6 μ apart. Stalk cell short, 3 to 4 μ, head cell ovate, regular. Mucronate hyphopodia ampulliform, narrow.

Perithecial setæ none. Mycelial setæ very numerous, 220 μ long, 7 μ thick at base, dentate with two to five short teeth, usually 3 to 5 μ long, sometimes forked with two branches 20 μ long and these with short teeth. Perithecia globose, smooth, 145 to 150 μ in diameter. Asci evanescent, 2-spored. Spores 4-septate, 47 to 53 by 16 to 21 μ.

Group number 31¾–3.5221.

A strikingly unique character of this fungus is that the mycelial strands near the edge of the colony for a zone some 150 to 200 μ wide, run parallel with each other and touching each other and in this zone they are almost or quite devoid of hyphopodia.

On Rutaceæ: *Micromelum minutum.* San Jose to Balete Pass, Nueva Ecija Province, Luzon, January 6, 1931, No. 1726.

This species differs from all of the nineteen species of *Meliola* described as on the Rutaceæ. It is most nearly related perhaps to *M. tenella*, *M. bambusae* var. *atlantiae*, and *M. evodiae*. From *M. tenella* and *M. bambusae* var. *atlantiae* it differs in having a dense colony. *Meliola evodiae* does have a dense colony but does not have the character of colony given above, nor are its setæ so long.

GROUP 4. Formula 313–.

MELIOLA BENGUETENSIS sp. nov. Fig. 2, c.

Colony 1 to 6 mm in diameter, amphigenous, very black, very dense. Mycelium 6 μ thick, smooth. The mycelium at the edge of a colony constituting a zone about 200 mm wide that is pale and devoid of hyphopodia and setæ. Spot pale yellow, devoid of chlorophyll, visible from both sides of the leaf. Capitate hyphopodia alternate or unilateral, somewhat crowded. Stalk cell short, 3 to 4 μ, head cell subglobose, regular. Mucronate hyphopodia ampulliform, very irregular, numerous on some hyphæ, mostly opposite.

Perithecial setæ none. Mycelial setæ very black, 250 to 270 μ long, 10 μ thick at base, with 2, 3, or 4 short, 6- to 7-μ teeth at apex. Perithecia globose, smooth, 145 to 160 μ in diameter. Asci evanescent. Spores 4-septate, 47 to 50 by 17 μ.

Group number 3131.4221.

On Sapindaceæ: *Otophora* sp. Kennon Road, Benguet, Luzon, January 8, 1931, No. 670 (type); San Jose-Balete Road, Nueva Ecija Province, Luzon, January 10, 1931, No. 1794.

The only species of *Meliola* upon the Sapindaceæ of the formula 3131. are *M. paulliniae* var. *dentata* and *M. sapindi*, the latter differing from the present form in having irregular head cells, while the former is distinguished by its thin colony.

The colony edge of the species is characteristic.

MELIOLA PISTACIAE sp. nov. Fig. 2, d.

Colony 1 to 3 mm in diameter, circular, densely black, amphigenous but mainly epiphyllous, also caulicolous. Mycelium 6 μ thick, densely crowded. An outer zone of each colony consists of paler mycelium that bears no hyphopodia or setæ. Spot none. Capitate hyphopodia alternate, very rarely opposite, closely crowded. Stalk cell short, 3 μ, head cell subglobose, regular. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ 233 to 277 μ long, 8 μ thick at base, apex bearing two or three short, 5 to 9 μ,

acute teeth. Perithecia globose, smooth, 145 μ in diameter. Asci evanescent. Spores 4-septate, 43 by 16 μ.

Group number 3131.5221.

On Anacardiaceæ: *Pistacia* sp. San Jose to Balcte Pass, Nueva Ecija Province, Luzon, January 9, 1931, No. 1712.

Three species of *Meliola* of the formula 3131. have their type forms on the Anacardiaceæ. Two of these have cristate setal tips, thus disagreeing with the present species. From the third species, *M. brachyodonta* Syd., it differs decidedly in the colony character described above.

MELIOLA THEMEDAE sp. nov. Fig. 2, e.

Colony amphigenous, 1 to 3 mm in diameter, black, dense, almost crustose. Mycelium 6 to 7 μ thick, straight, longitudinally on the leaf, crooked transversely. Spot none. Capitate hyphopodia alternate. Stalk cell to 10 μ long, head cell irregular, angular. Mucronate hyphopodia ampulliform, small.

Perithecial setæ none. Mycelial setæ stiff, straight, black, 160 to 190 μ long, 10 μ thick at base, somewhat enlarged and divided into numerous short teeth at tip, subcristate. Perithecia globose, smooth, 130 to 145 μ. Asci and spores not seen.

Group number ?131.??21.

On Gramineæ: *Themeda gigantea.* Muñoz, Nueva Ecija Province, Luzon, October 3, 1930, No. 794.

The setal tips are quite striking, different from any others that the senior author has seen.

GROUP 5. Formula $31\frac{2}{3}$–. or $31\frac{1}{3}$–. or $31\frac{1}{2}$–.

MELIOLA HETEROCEPHALA Sydow.

Group number $31\frac{2}{3}$–1.3221.

This is a well-defined species characterized by its irregular setal tips on setæ that abound only near the perithecia. Occasionally a leaf bearing *M. desmodii* may also have colonies of *M. heterocephala.* The two colonies on close observation can be distinguished by their habit and by the capitate hyphopodia. On *Desmodium* occur several forms of *Meliola* recorded as distinct species, and the number on the Leguminosæ is very large. Many of these show a common character, probably indicating a common ancestry, in their small, globose, capitate hyphopodia. These segregate into species since some have the hyphopodia strictly opposite, others strictly alternate, etc.; also by variation in the length of the mycelial setæ or in possessing characteristic setal tips. Frequently two nearly related species occur

on the same leaf and at first may then be puzzling to the taxonomist.

MELIOLA LITSEAE Sydow.

Group number $31\frac{1}{3}$–1.4223.

This species is very common in the Philippines and is much more variable than the description of Sydow would lead one to expect. Sydow's description gives the setæ as 350 to 700 μ long, while on some of our specimens we find them over 1,400 μ, others being as short as is indicated by Sydow's description. In length of setæ this species resembles *M. magna* Stevens described from Costa Rica on *Nectandra*. No other species upon the Lauraceæ and, indeed, but few other species of *Meliola* have setæ more than 1 mm long. This species differs strikingly from *M. magna* in its smaller spores.

MELIOLA NEPHELIICOLA sp. nov. Fig. 2, f.

Colony 3 to 10 mm in diameter, hypophyllous, black, indefinite, adhering very closely to the leaf surface. Mycelium 4 to 5 μ thick, crooked. Spot none. Capitate hyphopodia alternate or opposite. Stalk cell short, 3 to 4 μ, head cell subglobose. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ 185 to 470 μ long, 10 μ thick at base, either simple and acute or with a few very minute teeth. Perithecia globose, smooth, 150 to 190 μ in diameter. Asci evanescent. Spores 4-septate, 40 by 13 μ.

Group number $31\frac{1}{3}$–3.3222.

On Sapindaceæ: *Nephelium intermedium.* Mount Maquiling, Laguna Province, Luzon, July 22, 1930, No. 77.

This differs from *M. capensis* in that it has a much less dense colony; its hyphopodia are not always opposite as they are in *M. capensis.* It differs from *M. variaseta* in its acute setal apices. It differs from *M. nephelii* in shape of hyphopodia and abundance of setæ.

GROUP 6. Formula 312–. or $31\frac{1}{2}$–.

MELIOLA MEGALOPODA Sydow.

Group number 3121.5343.

This species was described by Sydow as on an unknown host. Ranger Mamerto Sulit, of the School of Forestry, Los Baños, has kindly determined the host of the type specimen as *Eugenia,* of the Myrtaceæ. It appears to be closely related to *M. densa* but differs from it in having much shorter setæ.

MELIOLA ANDROPOGONIS sp. nov. Fig. 3, l.

Colony epiphyllous, circular or ovate, 1 to 3 mm in diameter, black, dense. Mycelium 6 to 7 μ thick, straight. Spot none. Capitate hyphopodia alternate. Stalk cell short, 3 to 4 μ, head cell ovate, subglobose or more often angular. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ simple, obtuse, hamate, 140 to 220 μ long. Perithecia globose, smooth. Asci evanescent. Spores 4-septate.

Group number 3121. – – –1.

On Gramineæ: *Andropogon halepensis*. Naguilian Road, Benguet, Luzon, January 7, 1931, No. 1577.

Of the thirteen species of *Meliola* recorded on the Gramineæ only *M. panici* has been reported as on *Andropogon*. The hamate setæ and the irregular hyphopodia characterize the present species.

GROUP 7. Formula 3113.

MELIOLA SYMPHOREMAE sp. nov. Fig. 2, g.

Colony 5 to 10 mm in diameter, indefinite, black, hypophyllous. Mycelium 6 μ thick, somewhat crooked. Spot none. Capitate hyphopodia opposite or alternate, mainly opposite, pairs somewhat crowded, often only 13 μ apart. Stalk cell short, 3 to 4 μ, head cell irregularly ovate or oblong, 10 to 13 μ long. Mucronate hyphopodia ampulliform, very numerous, alternate or opposite, mostly opposite, 30 μ long, 7 μ wide.

Perithecial setæ none. Mycelial setæ numerous, 300 to 585 μ long, 10 μ thick at base, black, simple, obtuse or acute. Perithecia globose, smooth, 190 μ in diameter. Asci evanescent. Spores 4-septate, 40 by 17 μ.

Group number 3113.3223.

On Verbenaceæ: *Symphorema luzonicus*. Mount Maquiling, Laguna Province, Luzon, No. 655.

Only one species of the formula 3113, *M. callicarpae*, is recorded as on the Verbenaceæ and that has shorter setæ and smaller, more regular head cells and is a very distinct species. On the type material there is another *Meliola*, undetermined, that has strictly alternate capitate hyphopodia and the colony of which is thinner, more diffuse. Both of these species are parasitized by a *Helminthosporium*, which, however, is of much more dense growth on the undetermined *Meliola* than upon *M. symphoremae*, indicating that these parasites upon the *Meliola* are biologically differentiated as to their hosts.

MELIOLA KOAE Stevens.

Group number 3113.4231.

The specimens on *Acacia confusa* in the Philippine Islands show no differences from the type material collected by the senior author on *Acacia koa* in Hawaii. Though these two species of *Acacia* are both phyllodinous, they are not closely allied. It seems probable that both species of hosts derived the *Meliola* from some remote ancestor, probably Australian.

MELIOLA BAKERI Sydow.

Group number 3113.4222.

A collection was made on Mount Maquiling on *Cissampelos* on which genus it has not before been reported.

MELIOLA GLABRIUSCULA Spegazzini.

Meliola glabriuscula SPEGAZZINI, Rev. Mus. La Plata 15 (1908) 15.

Group number 3113.3231.

This species is recorded in the senior author's monograph, based on the original description, as of the formula 3112. Study of Spegazzini's original specimen shows the hyphopodia often to be alternate; therefore, the above formula is correct.

MELIOLA CALLICARPAE Sydow.

Group number 3113.3222.

The form of this species that occurs upon *Callicarpa ereoclona* differs slightly from the type, but this is not other than might be expected, owing to the fact that *C. ereoclona* is densely covered with hairs while *C. cana* is not.

GROUP 8. Formula 3112.

MELIOLA OPPOSITA Sydow.

Group number 3112.3222.

On *Aglaia diffusa*. Mount Maquiling, Laguna Province, Luzon. This fungus had not been reported on this genus.

MELIOLA PISONIAE sp. nov. Fig. 2, h.

Colony 1 to 3 mm in diameter, hypophyllous, circular, densely black, velvety, falling away from the leaf when dry. Mycelium 6 to 7 μ thick, dark, smooth, straight. Spot none. Capitate hyphopodia opposite, densely crowded, touching. Stalk cell short, head cell entire, globose. Mucronate hyphopodia ampulliform, not numerous.

Perithecial setæ none. Mycelial setæ straight, stiff, simple, acute, black, to 10 μ thick at base, 540 to 730 μ long. Peri-

thecia numerous, globose, 146 to 189 μ, surface slightly rough. Asci evanescent. Spores 44 to 50 by 13 to 14 μ.

Group number 3112.4223.

On Nyctaginaceæ: *Pisonia umbellifera.* Mount Maquiling, Los Baños, Laguna Province, Luzon, August 8, 1930, No. 373 (type).

Only two species have heretofore been reported as upon species of the Nyctaginaceæ—namely, *M. pulchella* and *M. eriophora*—both of which differ markedly from the present species. The most striking character of this species is the densely black colony composed of mycelium that branches so closely as to form a dense mat over the occupied area. The very crowded condition of the capitate hyphopodia also adds to the density of the colony.

MELIOLA MALACOTRICHA Spegazzini.

Group number 3112.3231.

Collections were made on *Hewittia sublobata, Hewittia bicolor, Lepistemon bebictariferum,* and an undertermined *Ipomoea.* Though not reported from the Philippines as this species before, it has been reported under its various synonyms.

MELIOLA RUBI sp. nov. Fig. 2, 1.

Colony 1 to 3 mm in diameter but very abundant and often coalescing to cover large areas of the leaf, black hypophyllous. Mycelium 6 to 7 μ thick, slightly crooked, with a strong tendency to branch at right angles and opposite. Spot none. Capitate hyphopodia nearly always opposite, usually about 17 μ apart. Stalk cell short, 3 to 4 μ, head cell oblong, about 14 by 7 μ, sometimes somewhat irregular. Mucronate hyphopodia long, conic.

Perithecial setæ none. Mycelial setæ simple, straight, acute, 277 μ long, 6 to 7 μ thick at base, quite numerous and distributed generally over the mycelium; that is, not limited to the perithecial region. Perithecia globose, smooth, about 90 μ in diameter. Asci evanescent. Spores 4-septate, 47 to 50 by 17 μ.

Group number 3112.4211.

On Rosaceæ: *Rubus molucanus.* Naguilian Road, Benguet, Luzon, January 6, 1931, No. 1469.

Comparison of this species with the type of *M. glabriuscula,* the only other *Meliola* recorded as on the Rosaceæ, shows very distinct differences, particularly as the mycelial setæ in *M. glabriuscula* are limited to the neighborhood of the perithecia,

while in the present species they are widely distributed on the mycelium.

MELIOLA AGELAEAE sp. nov. Fig. 3, g.

Colonies amphigenous, irregularly circular, 3 to 8 mm in diameter, dense to crustose, black, often variously parasitized. Mycelium 6 to 7 μ thick, dark. Capitate hyphopodia opposite, close together. Stalk cell short, 3 to 4 μ, head cell cylindrical, oblong. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ simple, acute, 365 μ long, 10 to 11 μ thick at base. Perithecia globose, smooth, 140 to 180 μ in diameter. Asci evanescent. Spores 4-septate, 47 by 17 μ.

Group number 3112.4222.

On Connaraceæ: *Agelaea* sp. Quezon Forest Park, Tayabas Province, Luzon, November 31, 1930, No. 439.

The strictly opposite capitate hyphopodia are characteristic. Only two species of *Meliola,* and these with alternate hyphopodia, are recorded on the Connaraceæ.

GROUP 9. Formula 3111. s. obtuse.

MELIOLA JASMINICOLA P. Hennings.

Meliola jasminicola was originally described by P. Hennings in 1895 on specimens from Hanoi, Tonkin. In this description he made no reference to the position of the capitate hyphopodia, though he did state that *M. jasminicola* was like and related to *M. polytricha* Kalchbrenner and Cooke, which later species has alternate hyphopodia. Examination of the type specimen of *M. jasminicola* shows that specimen to have alternate capitate hyphopodia. For these reasons, in the senior author's monograph, page 257, he gave the formula for this species as 3111., indicating alternate hyphopodia.

Bal states that the capitate hyphopodia are either opposite or alternate, a condition that we find in all of our specimens. The formula, therefore, should be 3113.

Mr. Willard H. Watts, who examined many collections of the senior author's Philippine material, states: "The young colonies appear to have just as many alternate and opposite hyphopodia as the older colonies. In many cases the hyphopodia were found arising only on one side of the mycelium (fig. 1). Others showed alternate and opposite hyphopodia arising on the same mycelial branch (fig. 2). No definite conclusions could be reached as to why the hyphopodia should be alternate in some parts and opposite in other parts of the same colony."

MELIOLA ALIENA Sydow.

Group number 3111.4221.

This was described by Sydow as on an unknown host. Ranger Sulit, of the School of Forestry, Los Baños, has determined the host of the type specimen for the senior author as *Pahudia rhomboidea*, one of the Leguminosæ.

The senior author is unable to identify *M. aliena* with any of the seventeen species of *Meliola* of the formula 3111. recorded as on the Leguminosæ. This, therefore, must be regarded as the eighteenth of that group.

MELIOLA SAMARENSIS Yates.

Group number 3111.4233.

This was originally reported by Yates as on an unknown host. Ranger Sulit, of the School of Forestry, says that the host is *Lepisanthes* of the Sapindaceæ. There are four species of similar formula upon the Sapindaceæ, but none seems to be identified with *M. Samarensis* which, therefore, stands as on the Sapindaceæ.

MELIOLA PSYCHOTRIAE Earle.

Group number 3111.3221.

A collection was made in Quezon Forest Park, Tayabas Province, Luzon, on *Neonauclea* which the senior author believes referable to this species. This is the first record of *M. psychotriae* in the Philippines and the first record of any *Meliola* on a *Neonauclea*.

MELIOLA EPITHEMAE sp. nov.

Colonies amphigenous, indefinite, black. Mycelium irregular, smooth, black. Spot none. Capitate hyphopodia alternate, close together. Stalk cell short, 3 to 4 μ, head cell ovate to pyriform, regular. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ simple, obtuse, straight, 250 to 360 μ long. Perithecia globose, smooth, 130 μ in diameter. Asci evanescent. Spores 4-septate, 26 to 30 by 10 to 11 μ.

Group number 3111.2222.

On Gesneriaceæ: *Epithema* sp. Naguilian Road, Benguet, Luzon, January 7, 1931, No. 1594.

Only two species of the formula 3111. with obtuse setæ have been noted on the Gesneriaceæ, and both of these have shorter setæ than the present species.

MELIOLA PETRAKII comb. nov.

Meliola petiolaris PETRAK, Anal. Mycol. 29 (1931) 185 non *M. petiolaris* Doidge, 1920.

Group number 3111.5432.

On Meliaceæ: *Dysoxylum cumingianum.* Type locality, Philippines.

MELIOLA ILLIGERAE sp. nov. Fig. 3, a.

Colony 1 to 3 mm in diameter, epiphyllous, black, velvety. Mycelium 8 to 9 μ thick, crooked. Spot none. Capitate hyphopodia alternate, not crowded, sometimes very distant, 170 μ. Stalk cell long, 3 to 16 μ. Head cell oblong to clavate, regular or slightly irregular, 30 by 17 μ. Mucronate hyphopodia ampulliform, small, 16 to 20 μ long.

Perithecial setæ none. Mycelial setæ 500 to 730 μ long, 10 μ thick at base, simple, obtuse, slightly curved. Perithecia globose, smooth, 160 to 175 μ in diameter. Asci evanescent. Spores 4-septate, 40 to 43 by 13 to 14 μ.

Group number 3111.3223.

On Hernandiaceæ: *Illigera luzonensis.* Naguilian Road, Benguet, Luzon, January 5, 1931, No. 1524.

No *Meliola* has heretofore been reported upon a plant of this family.

MELIOLA MELIACEARUM sp. nov. Fig. 3, b.

Colony very thin, pale, hypophyllous, 1 to 2 cm in diameter. Mycelium crooked, black, smooth, 6 to 7 μ thick. Spot none. Capitate hyphopodia alternate, scattered, far apart, often 170 μ. Stalk cell long, to 10 μ. Head cell oblong to irregular pyriform and angled. Mucronate hyphopodia ampulliform, long, to 33 μ, crooked, narrow.

Perithecial setæ none. Mycelial setæ long, to 880 μ, flexuous, simple, obtuse, very numerous near the perithecia, rare elsewhere. Perithecia globose, smooth, 160 μ in diameter. Asci evanescent. Spores 4-septate, 40 by 16 μ.

Group number 3111.3223.

On Meliaceæ: *Dysoxylum cumingianum.* Mount Maquiling, Laguna, Luzon, October 7, 1930, No. 824 (type); San Jose to Balete Pass, Nueva Ecija Province, Luzon, January 10, 1931, No. 1767.

The species is characterized by the very loose colony, the distant capitate hyphopodia, the long ampulliform hyphopodia, and the long setæ near the perithecia, which distinguish it from the numerous species of *Meliola* described as on the Meliaceæ. It differs from *M. banahaoensis,* described on *Dysoxylum,* in its

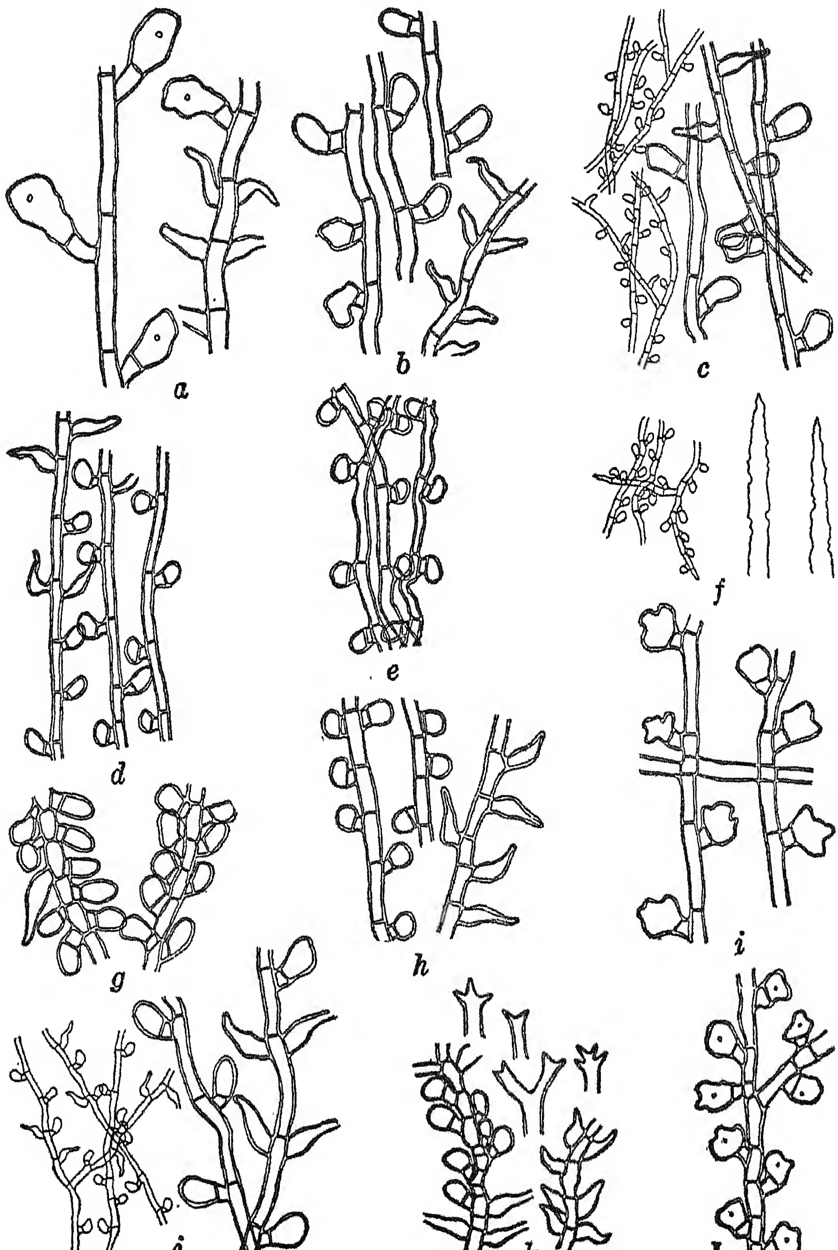

FIG. 3.

less dark, less dense colony and in setal tips. It is sparsely represented on all specimens collected and is usually accompanied by one or more other species of *Meliola* that, however, were not in determinable condition.

MELIOLA SAKAWENSIS P. Hennings.

Group number 3111.3221.

Collections were made upon *Premna subscandens* and *Symphorema luzonicum.* The latter is a new host genus, and the former a new Philippine record.

MELIOLA GARUGAE sp. nov.

Colony thin, almost invisible, hypophyllous, indefinite, 3 to 5 mm in diameter. Mycelium 6 to 7 μ thick, slightly crooked. Spot none. Capitate hyphopodia alternate, not crowded. Stalk cell short, 3 to 4 μ, head cell subglobose to ovoid. Mucronate hyphopodia ampulliform, straight or crooked.

Perithecial setæ none. Mycelial setæ very few, 140 to 250 μ long, obtuse. Perithecia globose, black, smooth, 70 to 80 μ in diameter. Asci evanescent. Spores 4-septate, 40 to 43 by 16 μ.

Group number 3111.4211.

On Burseraceæ: *Garuga abilo.* Muñoz, Nueva Ecija Province, Luzon, October 3, 1930, No. 781.

This differs markedly in mycelium, hyphopodia, and setæ from the only *Meliola* of the formula 3111. so far reported upon the Burseraceæ. No *Meliola* has heretofore been reported upon *Garuga.*

MELIOLA MICROSPORA Patouillard and Gaillard.

Group number 3111.2121.

Collection was made on Mount Santo Tomas, Benguet, Luzon, on *Leucas*, on which it has not before been reported.

MELIOLA PANICI Earle.

Group number 3111.3223.

The length of setæ in various collections varies considerably. As described, they are from 400 to 600 μ long. Most of the collections from the Philippines on *Rottboellia* fall within these limits, though collection No. 1544 had very short setæ, barely 204 μ long.

On Gramineæ: *Miscanthus.* Naguilian Road, Benguet, Luzon.

This is the first record of a *Meliola* on *Miscanthus.* This is probably *M. panici*, but all the specimens are so heavily overgrown by parasites that definite determination is impossible.

MELIOLA PTEROSPERMICOLA sp. nov. Fig. 3, e.

Colony 3 to 10 mm in diameter, epiphyllous, very thin, indefinite. Mycelium 6 μ thick, nearly straight, wine-colored, smooth. Spot none. Capitate hyphopodia alternate, not crowd-

ed, 30 to 85 μ apart. Stalk cell short, 3 to 4 μ, head cell clavate, to 23 μ long. Mucronate hyphopodia ampulliform, small, about 16 μ long.

Perithecial setæ none. Mycelial setæ simple, to 350 μ long, 9 μ thick at base, somewhat crooked, obtuse, black. Setæ from near the base of the perithecium shorter, 135 μ. Perithecia globose, smooth, 150 μ in diameter, originally flat and surrounded by radiating hyphæ, at maturity globose. Asci evanescent. Spores 4-septate, 36 to 40 by 16 μ.

Group number 3111.3221.

On Sterculiaceæ: *Pterospermum obliquum.* Agricultural College, Laguna Province, Luzon, September 10, 1930, No. 498.

Though similar to *M. pterospermi,* the only other species recorded as upon the Sterculiaceæ, in formula this differs from it in its thin, not black and dense colony and in its regular head cells as well as in length of setæ.

MELIOLA PISONIICOLA sp. nov. Fig. 3, d.

Colony 2 to 10 mm in diameter, thin, diffuse, indefinite. Mycelium 6 to 7 μ thick, somewhat crooked. Spot none. Capitate hyphopodia alternate. Stalk cell short, 3 μ, head cell subglobose to ovate. Mucronate hyphopodia ampulliform, short, thick.

Perithecial setæ none. Mycelial setæ to 185 μ long, 6 to 7 μ thick at base, simple, slightly curved, obtuse. Perithecia globose, smooth, 70 to 80 μ in diameter. Asci evanescent. Spores 4-septate, 23 by 10 μ.

Group number 3111.2111.

On Nyctaginaceæ: *Pisonia,* San Jose to Balete Pass, Nueva Ecija Province, Luzon, January 10, 1931, No. 1813.

This differs decidedly from *M. pisoniae* Stevens, which has opposite capitate hyphopodia and a very dense and black colony.

MELIOLA BRIDELIAE sp. nov. Fig. 3, e.

Colony thin, circular, 3 to 10 mm in diameter, epiphyllous, inconspicuous. Mycelium irregular, crooked, thin, 4 to 5 μ. Spot none. Capitate hyphopodia unilateral or alternate, not crowded. Stalk cell short, 2 to 3 μ, head cell cylindrical or oblong, standing out at a right angle or leaning abruptly forward. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ few, scattered, 580 to 800 μ long, obtuse, simple, slightly curved, 6 to 7 μ thick at base, discal setæ few, 4 to 8 at the base of each perithecium, 250 μ long. Perithecia globose, smooth, 116 to 120 μ in diameter. Asci evanescent. Spores 4-septate, 37 by 13 μ.

Group number 3111.3223.

On Euphorbiaceæ: *Bridelia stipularis*. Naguilian Road, Benguet, Luzon, January 6, 1931, No. 1543.

The colonies are very inconspicuous due to the scant mycelium loosely distributed over the leaf. Under the low power of the microscope a striking character is presented by the few long black mycelial setæ. The two forms of mycelial setæ are quite distinctive. This *Meliola* differs distinctly from all of the other species recorded upon the Euphorbiaceæ in its simple mycelial setæ of two lengths, alternate, capitate hyphopodia, and setæ more than 500 μ long.

MELIOLA SIDAE Rehm.

Group number 3111.2121.

In specimens Nos. 801, 1714, 1723, 1061, on *Sida acuta*, each perithecial disk bore upward of twelve setæ and no setæ at all were seen on the mycelium itself. The same condition we find in Fungi Malayana No. 255. In case the mycelial setæ are consistently absent, only the discal being present, the formula should be 3111.2121. If the mycelial setæ are entirely absent and the setæ around the perithecia are regarded as arising from the perithecia rather than from the disks, then the formula would be 3401.2121. and the fungus would belong to the genus *Irenopsis*. The fact that four varieties of *Irenopsis* have been described on the Malvaceæ is significant and, in view of the variability of Philippine collections of *M. sidae*, shows a close kinship between all of these forms.

MELIOLA STRYCHNICOLA Gaillard.

Group number 3111.4221.

The Philippine material has a colony that is considerably more tenuous than the senior author's own collection from Panama and there are minor differences in capitate hyphopodia, but it seems well to regard the two as identical.

MELIOLA TABERNAEMONTANAE Spegazzini.

Group number 3111.4221.

On *Tabernaemontana* sp. San Jose-Balete Pass Road, and Muñoz, Nueva Ecija Province, Luzon.

This appears to be the first record of this fungus in the Philippines.

MELIOLA MYCETIAE Stevens, sp. nov. Fig. 3, f.

Colonies amphigenous, small, 1 to 2 mm in diameter, black, of medium density. Mycelium dark, thick, 7 to 8 μ irregular to

crooked. Spot none. Capitate hyphopodia alternate, slanting forward. Stalk cell long, 6 to 8 μ, head cell ovate, regular. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ usually scant except near the perithecia, simple, obtuse, 190 to 205 μ long, very slightly undulate. Perithecia globose, smooth, 145 to 175 μ in diameter. Asci evanescent. Spores 4-septate, 37 to 40 by 13 to 16 μ.

Group number 3111.3221.

On Rubiaceæ: *Mycetia javanica.* Kennon Road below Camp 3, Benguet, Luzon, January 8, 1931, No. 1669.

This appears to be the first record of *Meliola* upon *Mycetia.* This species is more closely related to *M. eveae, M. ouroupariae,* and *M. psychotriae* than to the other very numerous species of the Meliolineæ that are recorded on the Rubiaceæ. Ours differs from *M. eveae* in the character of the mycelium, which in *M. eveae* is thinner and paler than in the present species. The capitate hyphopodia in *M. eveae* are also shorter.

Meliola psychotriae has mycelium and hyphopodia of lighter color. *Meliola ouroupariae* differs very decidedly in its great abundance of setæ, and in the small, nearly globose head cells. The present form differs also from each of the three mentioned above in the undulate character of the mycelial setæ.

A common character of many of the Meliolineæ occurring upon the Rubiaceæ is that the capitate hyphopodia lean forward, toward the distal end of the mycelium that bears them, making an angle of approximately 90 degrees with the supporting hypha. This character is typically shown in the present species as well as in *M. psychotriae.* Another character common to the forms on the Rubiaceæ is that the head cells are entire, usually ovate.

GROUP 10. Formula 3111. Setæ obtuse or acute.

MELIOLA CANARII Sydow.

Group number 3111.422$\frac{2}{3}$.

On Burseraceæ: *Canarium villosum.* Mount Maquiling, Laguna Province, Luzon, July 22, 1930, No. 83.

Comparison of the present collection with a specimen No. 23877 of the Philippine Bureau of Science and 363 and with Fungi Malayana No. 547 convinces us that the determination of the above specimen is correct. We note, however, three important differences between this specimen and Sydow's description.

1. Sydow describes the fungus as epiphyllous, while the present specimen shows it to be amphigenous.

2. Sydow makes no mention of deform mycelial setæ, while we find, as well as the long mycelial setæ that he describes, also other mycelial setæ which occur only near the bases of the perithecia, these setæ being few and short, 140 to 150 μ.

3. The length of the mycelial setæ is given in Sydow's description as 300 to 550 μ, while in our specimens they reach 730 μ in length and are rarely below 500 μ.

MELIOLA PIPERINA Sydow.

Group number 3111.3222.

Two species of *Meliola* of nearly the same formula—namely, *M. stenospora* Winter 3111.4222 and *M. piperina* Sydow 3111.3222—are recorded as on *Piper* in the Philippines. *Meliola stenospora* was described as with "hyphopodia promaxima parte late pyriformia, varie lobata."

Sydow says of *M. piperina*, "ausgezeichnet durch die stark gelappten Hyphopodien. Mit *M. stenospora* Wint. nächst verwandt."

The senior author is unable to examine a type specimen of *M. stenospora*, but he has specimen No. 770 of the Bureau of Science, also a Kew specimen from Uganda, determined by Miss Wakefield as this species. Comparison of these with specimens of *M. piperina* Fungi Malayana No. 367 and Bureau of Science No. 23749 shows no differences.

MELIOLA SUBSTENOSPORA v. Höhnel.

Group number 3111.4223.

On *Oplismenus undulatifolius*.

In some specimens the setæ measure up to 540 μ thus making the last figure of the formula 3 instead of 2 as is indicated by the original description. The mycelium usually parallels the veins in the way common on species growing upon grasses.

MELIOLA ICHNOCARPI sp. nov.

Colony 2 to 5 mm in diameter and circular or irregularly diffuse, spreading, thin, or coalescing and covering a large portion of the leaf. Mycelium 4 to 6 μ thick, nearly straight. Spot none. Capitate hyphopodia alternate, leaning slightly forward, not crowded, about 30 to 35 μ apart. Stalk cell short, 3 to 4 μ, head cell ovate, regular. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ 219 to 500 μ long, 7 μ thick at base, crooked, acute, simple. Perithecia globose, nearly smooth, 130 to 146 μ in diameter. Asci evanescent. Spores 4-septate, 30 to 33 by 13 to 14 μ.

Group number 3111.3222.

On Euphorbiaceæ: *Ichnocarpus volubilis*. Cuenca, Batangas Province, Luzon, September 28, 1930, No. 722a (type); Naguilian Road, Benguet, Luzon, January 5, 1931, No. 1465.

This species differs from *M. ramosii* in having shorter and obtuse setæ; from *M. longispora* in that the hyphopodia are ovate, not globose; from *M. gymnanthicola* and its variety in colony appearance and in setal tips; from *M. calliguajae* in its small perithecia; from *M. euphorbiae*, *M. sauropicola*, and *M. heveae* in setal tips; from *M. jatrophae* in its longer setæ; and from *M. morbosa* in not causing a spot.

MELIOLA MYRTACEARUM sp. nov.

Colony thin, diffuse, epiphyllous. Mycelium 6 to 7 μ thick, dark, smooth. Spot none. Capitate hyphopodia unilateral or alternate. Stalk cell short, 3 to 4 μ, head cell subglobose to pyriform or oblong, mostly oblong. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ 525 to 730 μ long, 7 μ thick at base, black, crooked, acute at tip. Perithecia globose, 190 μ, rough. Asci evanescent. Spores 3-celled, 40 to 44 by 16 to 17 μ.

Group number 3111.4223.

On Myrtaceæ: *Eugenia*. Mount Maquiling, Laguna Province, Luzon, January 18, 1931, No. 1946.

This species differs from the species of *Meliola* recorded as on members of the Myrtaceæ having a formula of 3111. as follows: From *M. eugeniae*, *M. langiera*, *M. hawaiiensis*, and *M. laxa* in length of setæ and in its setæ being acute. It differs from *M. psidii* and *M. brasiliensis* in many respects.

An undetermined microthyriaceous fungus was very abundant on the lower sides of the leaves.

MELIOLA GLOCHIDII sp. nov.

Colony hypophyllous, black, velvety with setæ, 5 to 10 mm in diameter. Mycelium somewhat crooked, dark, 6 to 7 μ thick. Spot none. Capitate hyphopodia alternate or unilateral, irregularly spaced. Stalk cell short, 3 to 4 μ, head cell ovoid to mostly cuneiform, regular. Mucronate hyphopodia ampulliform, narrow, short.

Perithecial setæ none. Mycelial setæ most abundant near the perithecia, very black, straight, stiff, simple, acute, 10 μ thick, usually about 250 μ long. Perithecia at first flattened, later globose, black, smooth, 100 to 120 μ in diameter. Asci evanescent. Spores 4-septate, 47 to 50 by 16 μ.

Group number 3111.4221.

On Euphorbiaceæ: *Glochidion* sp. Naguilian Road, Benguet, Luzon, January 6, 1931, No. 1561.

This differs in colony character and in hypophyllous habit from *M. ramosii*, from *M. longispora* in mycelial and setal characters, from *M. gymnanthicola* in its hypophyllous colonies and head cells, from *M. jatrophae* in hyphopodia, and from *M. morbosa* in spot character.

MELIOLA EUCALYPTI sp. nov.

Colony to 14 mm in diameter, irregular, black, amphigenous. Mycelium 6 to 7 μ thick, almost straight. Spot none. Capitate hyphopodia alternate, not crowded, but close, about 17 μ apart. Stalk cell short, 3 to 4 μ; head cell oblong, regular or slightly irregular. Mucronate hyphopodia ampulliform, numerous, mostly opposite.

Perithecial setæ none. Mycelial setæ very few, 200 to 220 μ long, 9 to 10 μ thick at base, black, simple, acute. Perithecia globose, smooth. Asci evanescent. Spores 4-septate, 40 to 43 by 16 to 17 μ.

Group number 3111.4211.

On Myrtaceæ: *Eucalyptus*. San Jose to Balete Pass, Nueva Ecija Province, Luzon, January 9, 1931, No. 1722.

This differs markedly from all species of *Meliola* of formula 3111. recorded on the Myrtaceæ and from all species recorded on *Eucalyptus*.

MELIOLA BANOSENSIS Sydow.

Group number 3111.3223.

On Leguminosæ: *Spatholobus gyrocarpus*. Mount Maquiling, Los Baños, Laguna Province, Luzon, September 13, 1930.

No *Meliola* has heretofore been recorded upon this host. Though the setæ in our specimen in general are longer than in Sydow's specimen and as indicated in his description, it appears well to regard the two specimens as of the same species.

MELIOLA PIPERINA Sydow.

Group number 3111.3222.

Collections were made on *Piper betle* on which species of host it has not previously been reported.

MELIOLA BARRINGTONIICOLA sp. nov. Fig. 3, h.

Colony 1 to 3 mm in diameter, black, moderately dense, epiphyllous, mycelium 6 to 7 μ thick. Spot none. Capitate hyphopodia alternate or partly unilateral. Stalk cell short, 3 to 4 μ, head cell subglobose. Mucronate hyphopodia ampulliform.

Perithecial setæ none. Mycelial setæ to 450 μ long, 9 to 10 μ thick at base, simple, acute, mostly near the center of the colony. Perithecia globose, smooth, 120 μ in diameter. Asci evanescent. Spores 4-septate, 40 by 17 μ.

Group number 3111.3222.

On Lecythidaceæ: *Barringtonia* sp. Quezon Forest Park, Tayabas Province, Luzon, November 30, 1930, No. 440.

This is quite distinct from *M. indica,* the only species recorded on this family, in not having the capitate hyphopodia opposite.

MELIOLA PARENCHYMATICA Gaillard.

Group number 3111.4232.

Four collections from Luzon agree with a specimen from the Bureau of Science and with Fungi Malayana No. 365, the distinguishing character being the irregular shape of the head cells. The original description gives the head cells as globose or ovoid and does not mention the irregularity, which in the Philippine specimens is strongly pronounced.

Genus MELIOLINOPSIS Beeli

MELIOLINOPSIS UVARIAE (Rehm) Beeli.

Group number 2111.4132.

Our specimens collected in Laguna agree precisely with the type specimen, but since neither possesses perithecia, the determination is questionable.

Numerous of the senior author's Meliolineæ collections are undeterminable due to such overgrowth by parasites as to prevent proper development of perithecia, setæ, etc., or to scanty collections which did not give the requisite characters for description.

It is obviously unwise to publish these with full descriptions and names, but since many of them represent new records on genera or families, it seems desirable to make record of their existence with a very brief description. In such cases the forms are designated by numbers, as follows:

No 1.—Colony 1 to 5 mm in diameter, diffuse. Capitate hyphopodia alternate, about 16 μ apart, head cells oblong.

On Ericaceæ: *Vaccinium benguetense.*

This is clearly not *I. exilis* or *I. andromedae.*

No. 2.—Capitate hyphopodia alternate. Head cell subglobose to ovate, regular.

On Thymelaeaceæ: *Wikstroemia.* Paete, Laguna Province, Luzon.

Only two species of the Meliolineæ are recorded on this family and neither of these from the Philippines.

No. 3.—Capitate hyphopodia alternate, head cell oblong or irregular, mycelial setæ 400 to 600 μ long, simple.

On Anacardiaceæ: *Semecarpus* sp. Mount Maquiling, Laguna Province, Luzon, No. 1921.

This is a very characteristic form. It is not *M. semecarpi*, the only species recorded on this family from the Philippines, which has longer setæ and many fewer capitate hyphopodia.

No. 4.—Capitate hyphopodia alternate, head cell irregular.

On Pandanaceæ: *Pandanus* sp. Louisiana, Laguna Province, Luzon, September 21, 1930, No. 676.

No species of the Meliolineæ has hitherto been recorded on the Pandanaceæ in the Philippines, though one species, *M. pandani*, is recorded from Borneo which is perhaps identical with this number.

No. 5.—Capitate hyphopodia alternate, head cell subglobose to slightly irregular, very regularly spaced, colony very thin.

On Sterculiaceæ: *Pterospermum niveum.*

No species is recorded on this host from the Philippines, only four species are recorded for this family in the world.

No. 6.—Capitate hyphopodia alternate, head cell ovate, regular.

On Anonaceæ: *Papualthia lanceolata.* Mount Maquiling, Laguna Province, Luzon.

Though numerous species are known on the Anonaceæ, none has heretofore been noted upon this genus. It was collected on Mount Maquiling several times but in all cases very heavily overgrown by a *Helminthosporium*, so heavily that the presence or absence of setæ could not be determined nor did perithecia develop.

No. 7.—Capitate hyphopodia numerous, alternate, head cell oblong or irregular, perithecia globose, smooth, colony dense.

On Sapotaceæ: *Palaquium* sp. Mount Maquiling, Laguna Province, Luzon.

No. 8.—Capitate hyphopodia few, distant, mycelial setæ more than 1,100 μ long, perithecia smooth, globose, colony very thin.

On Sapotaceæ: *Palaquium* sp. Mount Maquiling, Laguna Province, Luzon.

Nos. 7 and 8 occurred upon the same leaves but were too scant to be determined. They certainly are two very different species and differ from *M. palaquii*, the only Meliola that has been

recorded on *Palaquium*. None on the Sapotaceæ has setæ as long as those of No. 7.

No. 9.—Capitate hyphopodia alternate, head cell clavate, irregular, colony thin.

On Urticaceæ: *Oreocnide* sp. Acop's, Benguet Subprovince, Luzon.

No *Meliola* has been recorded on *Oreocnide*.

No. 10.—Capitate hyphopodia alternate, head cell clavate, irregular, mycelium crooked, mycelial setæ probably absent.

On Vitaceæ: *Leea philippinensis*. Mount Maquiling, Laguna Province, Luzon.

No *Meliola* has been recorded on this host.

No. 11.—Capitate hyphopodia alternate, head cell ovoid, regular, mycelium very crooked.

On Gesneriaceæ: *Isanthea discolor*. Balete Pass, Nueva Ecija Province, Luzon.

None has been recorded on this genus.

No. 12.—Capitate hyphopodia alternate, head cell ovate, mycelial setæ few, 80 to 90 μ long, obtuse.

On Compositæ: *Elephantopus*. Balete Pass, Nueva Ecija Province, Luzon.

None has been recorded on this genus from the Philippines.

No. 13.—Capitate hyphopodia alternate, head cell cuneiform or angular, mycelium crooked.

On Euphorbiaceæ: *Neotrewia cumingii*. Mount Maquiling, Laguna Province, Luzon.

No *Meliola* has been recorded upon this genus.

No. 14.—Capitate hyphopodia alternate, head cell ovate, regular, mycelial setæ long, to 500 μ, simple.

On Tiliaceæ: *Grewia*.

No *Meliola* has been recorded upon this host genus hitherto.

No. 15.—Capitate hyphopodia alternate, head cell ovate, regular.

On Proteaceæ: *Helicia* sp.

No *Meliola* has ever been reported on *Helicia*.

No. 16.—Capitate hyphopodia opposite, head cell conic-cylindric, mycelial setæ simple, to 450 μ long.

On Meliaceæ: *Dysoxylum*. San Jose to Balete Pass, Nueva Ecija Province, Luzon.

No. 17.—Capitate hyphopodia alternate, head cell very large and irregularly lobed.

On Symplocaceæ: *Symplocos*. Mount Maquiling, Laguna Province, Luzon.

No *Meliola* has been recorded for this family except the very questionable *M. amphitricha*, which in any event could not be the present species.

No. 18. Fig. 3, i.—Colony circular, epiphyllous, 3 to 7 mm in diameter, usually heavily covered by an *Arthrobotryum* and sometimes by a *Helminthosporium* as well. Mycelium smooth, 6 to 7 μ thick, loosely distributed; that is, not dense. Spot none. Capitate hyphopodia alternate. Stalk cell short, 2 to 3 μ, head cell rarely subglobose, usually irregularly angled. Mucronate hyphopodia ampulliform.

Perithecial setæ, mycelial setæ, perithecia, and spores not seen.

On Chloranthaceæ: *Chloranthus officinalis*. Mount Maquiling, Laguna Province, Luzon.

No species of *Meliola* has heretofore been recorded on any member of the Chloranthaceæ; though the present species was collected many times on Mount Maquiling at different elevations, in no instance was even a single colony seen that was not heavily overgrown by an *Arthrobotryum*, so heavily indeed that the *Meliola* mycelium was almost completely obscured and setæ and perithecia were entirely suppressed. A rather extraordinary feature of these colonies is that occasionally in the midst of mycelial strands that are heavily parasitized are a few that are not parasitized at all. The dense sheathing of the *Meliola* by the *Arthrobotryum* mycelium is very characteristic and it is only in rare bits that the *Meliola* mycelium and its hyphopodia can be seen.

In the absence of the usual *Meliola* characters, the chief distinctive character of this species is that of its being so heavily parasitized, and its host relation. The fact that this *Meliola* is so heavily parasitized, while most other species of *Meliola* in the vicinity are not, is strong evidence of the biologic specialization of these fungi growing parasitic on *Meliola*.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Species of *Meliola, Irenopsis,* and *Irenina.*

- *a. Meliola saurauiae* sp. nov., mycelium habit, low power, mycelium showing detail, and spore, high power.
- *b. Irenopsis benguetensis* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.
- *c. Irenina acalyphae* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.
- *d. Irenina rubi* sp. nov., mycelium showing habit, low power, and mycelium showing capitate and mucronate hyphopodia, high power.
- *e. Irenina rubi* Stevens var. *angulata* var. nov., mycelium showing capitate and mucronate hyphopodia, high power.
- *f. Irenina angustispora* sp. nov., mycelium showing habit, low power, and mycelium showing capitate hyphopodia, high power.
- *g. Irenina callicarpae* sp. nov., mycelium showing habit, low power, and mycelium showing capitate hyphopodia, high power.
- *h. Irenina thunbergiae* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.
- *i. Irenina sinuesa* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

2. Species of *Meliola.*

- *a. Meliola palaquii* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.
- *b. Meliola micromeli* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power, and setæ showing apices, high power.
- *c. Meliola benguetensis* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power, and setæ showing teeth, high power.
- *d. Meliola pistaciae* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power, and setæ showing teeth, high power.
- *e. Meliola themedae* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power, and seta showing tip, high power.
- *f. Meliola nepheliicola* sp. nov., mycelium showing capitate and mucronate hyphopodia, high power, and setæ showing apices, high power.

g. Meliola symphoremae sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

h. Meliola pisoniae sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

i. Meliola rubi sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

3. Species of *Irenopsis* and *Meliola.*

a. Meliola illigerae sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

b. Meliola meliacearum sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

c. Meliola pterospermicola sp. nov., mycelium habit, low power, and mycelium showing capitate and mucronate hyphopodia, high power.

d. Meliola pisoniicola sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

e. Meliola brideliae sp. nov., mycelium showing capitate hyphopodia, high power.

f. Meliola mycetiæ sp. nov., mycelium showing habit, low power, and setæ showing undulations, high power.

g. Meliola agelaeae sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

h. Meliola barringtoniicola sp. nov., mycelium showing capitate and mucronate hyphopodia, high power.

i. Meliola 18, mycelium showing capitate hyphopodia, high power.

j. Irenopsis coronata var. *philippinensis* var. nov., mycelium showing habit, low power, and mycelium showing capitate and mucronate hyphopodia, high power.

k. Meliola ganophylli sp. nov., mycelium showing capitate and mucronate hyphopodia, high power, and setæ showing apices, high power.

l. Meliola andropogonis sp. nov., mycelium showing capitate hyphopodia, high power.

ETHNOGRAPHIC STUDY OF THE YOGADS OF ISABELA

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THREE PLATES

INTRODUCTION

Many ethnographic studies on the different Philippine groups have been undertaken by eminent anthropologists and scientists, yet the Yogads have never been given proper attention, perhaps because of their small number and the similarity of their characteristics to those of the Gaddangs and the Ibanags. The literature references available on the group are very limited, being confined to their dialect, geographic location, and their relation to other ethnic groups. Blumentritt in 1890 only mentioned their geographic location and their relation to the Christianized Gaddangs. Pardo de Tavera in 1901 analyzed the etymology of their tribal name. Worcester in 1906 mentioned them as a part of the Christianized Kalingas of western Isabela. Malumbres in 1918 likewise mentions their geographic location and the relation of their dialect to the Gaddangs. The present writer attempts to present in this short paper a study of their economic and social life, and their dialect. In 1931, when he was officially sent to Isabela and Nueva Vizcaya Provinces to purchase museum specimens, he stayed with this group long enough to become acquainted with it; and, having been given the necessary facilities for ethnographic study, he was able to familiarize himself with the economic and social life of the Yogads, and the peculiarities of their dialect. These studies form the subject of the present discussion.

ORIGIN

The term Yogad, or Iogad, is derived from *ugad,* an Ibanag word meaning elevated garden patches or seed plots.

> Se conoce con el nombre de *yogades* (yogad ó *gaddanes* a unos montañeces que en la actualidad habitan en las vertientes de la cordillera central, límite occidental de la provincia de la Isabela, desde la orilla izquierda del Río Magat, término del Río Mercedes, hasta la jurisdicción de los pueblos cristianos de Itawes.

La etimología de ambos nombres nos la da la lengua ibanag que tanto se parece al gaddan, resultando que *gaddan* y *yogad* tienen la misma significación y origen, sólo que el primero es nombre de *lugar* y el segundo de *tribu*. Ambos derivan del radical *gad* cuya forma más antigua *ugad*, existe también en ibanag y significa "sementera alta". Esta raiz, seguida del sufijo *an*, quiere decir "lugar de la sementera alta" como *payaw* vimos que quería decir "sementera baja o de regadío". Los habitantes del *gaddan*, llamados hoy así con este nombre propio de personas, que es *yogad* formado con el prefijo *i* cuyo significado conocemos y el radical *ugad* igual a *gad* que hemos examinado.[1]

It is said that the Yogads, who regard themselves as offshoots of the Ibanags, originally came from the town of Enrile, formerly called Cabug, which was established in 1742 in Cagayan Province. Due to the crowded conditions of their native town and the difficulties encountered in the struggle for existence, this sturdy, peace-loving, and adventurous people decided to migrate to Isabela Province, to find a new home and to seek their fortune.

Worcester[2] states that the Yogads are a part of the Christianized Kalingas of western Isabela. These Kalingas are called Gaddangs, and were Christianized by missionaries.

GEOGRAPHIC DISTRIBUTION

The Yogads were at one time confined to the level land of the town of Difun, which was established in 1706. The principal towns which they now occupy are Camarag, the oldest town in Isabela, established in 1753, and Echague, Angadanan, Santiago, and Jones, formerly Cabanuangan.

POPULATION

The present number of the group speaking the Yogad dialect is conservatively estimated at 8,000. This number represents those who are regarded as being of pure stock. A few of them have migrated to neighboring provinces where they intermarried with the other Christian groups.

PHYSICAL TYPE AND CHARACTERISTICS

The Yogads are predominantly of the Indonesian type with a slight admixture of Negrito and Chinese blood. They vary from reddish brown to dark brown in complexion. They are round-headed, with straight, black hair, dark brown eyes, and a nose

[1] Pardo de Tavera, T. H., Etimología de los Nombres de Razas de Filipinas. Manila (1901) 14.

[2] Philip. Journ. Sci. 1 (1906) 818.

of medium breadth with a low bridge. They are of ordinary size and have unusually regular features. Like other Philippine peoples, they are practically beardless.

CULTURE

The Yogad culture, like that of the other Christian groups of the lowlands, is tinctured by Spanish civilization, although the people retain many of their primitive customs and beliefs.

ECONOMIC LIFE

Agriculture.—Formerly the Yogads practiced the kaiñgin system of agriculture, planting in cleared forest areas where the soil is loose and fertile. Under this system the small trees and shrubs are cut away and burned, and the large trees are killed.

According to the census of 1918 the climate of the plains occupied by the Yogads is very favorable to the growth of tobacco. The northeast monsoons bring heavy rains, which wash down the fertile mountain soil into the rivers that deposit the silt on the plains. In this manner the tobacco fields are fertilized every year.[3]

The principal product is tobacco, which is grown in large quantities. The variety of tobacco raised in this region is considered one of the best in the Philippines, and, as one of the principal articles of export, constitutes the wealth of the people. The corn crop is the object of considerable care on the part of the natives, as it constitutes their principal food supply when the price of rice is high. Rice, sugar cane, coconuts, and coffee, grow almost without the care of the planter. A few cattle are raised. The forests are rich in valuable timber, such as molave, ipil, narra, and camagon.

Hunting and fishing.—Hunting is carried on to a considerable extent. Wild pigs, carabaos, and deer are caught with snares, traps, and barbed spears that are similar to those of the Bontoc Igorots. The Sierra Madre Mountains are the hunting places of the Yogads.

Cagayan River has an abundant supply of fish, and fishing is one of the principal occupations of the people. Fish are caught with nets, lines, and traps, as well as with small barbed spears, and bows and arrows. Murrel fish constitute the principal catch.

Basketry.—The Yogads do considerable basket work. The principal materials used are bamboo, rattan, and nito. Four

[3] Census of the Philippine Islands: 1918 1 (1920) 167.

types of weave are employed; namely, "in and out" or cloth weave, twilling or sawale weave, hexagonal weave, and coiling. Some of their baskets are patterned after those of the Ilocanos and pagan tribes of northern Luzon.

Weaving of textiles and the making of pottery are unknown among the Yogads, who purchase most of their clothing from Ilocano and Chinese traders, and their pots and stoves from the Tinggians and Ilocanos.

Transportation.—The Yogads have transportation by land and water. Their typical land transportation is the cart drawn by a carabao or cow. Riding on horseback is also common on mountain trails.

Their typical water transportation is the raft, or *gakit*, and the dugout canoe, or *abáng*. The gakit, which is about 6 meters long, is made of mountain cane, or *buhu*, lashed together by rattan. It is used for transporting across Cagayan River mature tobacco leaves placed in big baskets called *tangkal*. The dugout canoe is used for fishing and passenger transportation.

Dwelling.—The Yogad dwelling is a structure of wood, bamboo, or mountain cane, with a thatched or bamboo roof. This kind of roofing, or *camá*, must be in imitation of the Ilocanos who commonly use it in roofing their houses. The sides or walls are made of sawale or mountain cane split into halves, which are placed so as to overlap one another. The floor is made of wood, sawale, or bamboo. The houses have only one partition and are raised 3 to 4 feet above the ground.

Dress and ornaments.—Yogad dress is similar to that of other Christian groups. The men wear shirt and trousers and the women camisa and skirt.

Yogads are not much given to personal ornamentation. Some of the men have tattoo marks on the arms and hands. Necklaces of beads and coconut shells, earrings, and finger rings are also worn to some extent.

SOCIAL LIFE

Music.—The Yogads, like the other Christian Filipinos, are very fond of music. Social gatherings and entertainments are always marked by singing and dancing.

The typical musical instrument of the Yogads is the *cinco-cinco*, a small five-stringed wooden guitar, which is used to accompany songs and dances. Other musical instruments are the *tal-lelet* and the *caralat*, or bamboo rattles. These are percussion bamboo musical instruments, which are played at night

during Holy Week. A band contest for these musical instruments is held by the different barrios at a designated place.

Dances.—The Yogads have four typical dances; namely, *mascota, a la jota, laurente,* and *balamban.* The first three dances are similar to each other although the music differs. They are danced, to the accompaniment of a cinco-cinco or an accordion, by a man and a woman facing each other. The rhythmic movement of the hands is emphasized. The balamban is also danced to particular music by a man and a woman, with special emphasis on the rhythmic movement of the feet. The name of this dance originated from the name of a long fish, called balamban, that jumps in the water.

Circumcision.—The Yogads, like some of the other Christian groups, practice circumcision. The boys are usually circumcised at twelve to fourteen years of age. The foreskin or prepuce of the penis is split with a sharp knife. Young guava leaves are masticated and the sap is applied as medicine. It takes ten to fifteen days to heal the wound. This practice is called *banguit.*

Marriage customs.—Generally speaking, the Yogads prefer to marry among themselves. They seldom intermarry with other Christian groups.

Formerly it was customary for the parents to make arrangements for the marriage of their children. Now it is left to the discretion of the boy and the girl. As soon as the boy wants to marry, his parents together with a spokesman go to the girl's parents and ask for her hand. They bring with them a drink, usually gin.

On the third day the spokesman of the boy's parents is told to come again to the house of the girl for the decision of the girl's parents. If the decision is favorable, the parents and relatives of both parties meet on the third day to make the final arrangement for the wedding.

Then the *landai* takes place. This is a feast prepared by both parties prior to the real wedding feast. A sort of poetical joust between the representatives of the boy and the girl usually takes place. While the contest is being held, the girl prefers to stay in the kitchen. The representative of the girl usually yields to the representative of the boy and then they all partake of the feast.

A band of music usually follows the bride and the groom on their way to the church where the wedding ceremony is to be performed.

After the wedding, the friends and relatives of the couple are entertained with a dance. Then follows what is called *gala*, or the giving of money to the couple. Two plates, one for the bride and the other for the groom, are placed on the table. The relatives of the bride and the groom put their money on the respective plates of the couple.

After the gala, the so-called *dal-lut* takes place. Only the relatives of both parties take part. It is usually performed at 3 or 4 o'clock in the morning. Some of the male relatives join their hands and some of the female relatives do the same. The male relatives of the couple are allowed by common consent to kiss the female relatives without holding them. After the dal-lut the girl goes to the parents of the boy, and the boy to the parents of the girl. Then they live together as husband and wife.

Superstitious beliefs.—The Yogads are a very superstitious people, especially those who live in Barrio Capitan, Echague. They believe in evil spirits, and the *Anitos,* who are said to cause sickness, which, however, may be cured by an *anting-anting,* or amulet.

The *carañgat,* or evil spirits, dwell in certain places, such as bamboo, *balete,* and *andarayan* trees. When a person gets sick, an old man called *maguimun* is summoned to find out whether the sickness is caused by the evil spirits. He asks the sick person where he went or played to ascertain the cause of his sickness. If the sickness is caused by the evil spirits, he takes little pieces of buyo, rolled tobacco leaves, rice (*malagquit*) placed in a coconut shell, and a white chicken and goes to the dwelling place of the spirits. He communes with the spirits, shouting at them and telling them to leave the sick person and to return to their dwelling places for he has prepared food for them. If the sickness of the person is very severe, the maguimun cuts the left leg of the chicken and the right leg is tied with a cotton thread. Then he anoints the forehead of the sick person with the chicken's blood. It is believed that the sickness will be cured in this manner.

The *mag-anito* is another common superstitious belief among the Yogads. They go to the forest for three days' festival during the dry season, taking with them pigs and rice. The *maponags,* or women mediums, are the ones who commune with the anitos. Part of the pigs is offered to the anitos, and the rest is cooked for the members of the party. The share offered to the anitos is usually given to the maponag. This yearly three-

day festival has to be repeated seven times. It is believed that after seven years the members of the party will be immune from sickness caused by the anitos. During these seven years, the members are not allowed to eat sugar and garlic. Only salt is allowed to be used in their food; nor are they allowed to repair their houses or use a white blanket or curtain.

Burial ceremony.—Before burial, a white handkerchief is spread on the face of the dead person. Then those present pray and leave the dead, except for the one who is to remain to hold the four corners of the handkerchief. As soon as the latter believes that the spirit of the dead is already in the handkerchief, he takes it home and walks around the house. It is believed that on the third day the spirit of the dead will visit them and stay only under the house if such a ceremony is not performed.

The members of the family are not allowed to stoop or look down when the coffin is being lowered into the grave, for it is the belief of the Yogads that he who looks down will also die.

After burying the dead, the members of the family wash their hands and faces with water mixed with burned straw.

For nine nights they pray for the spirit of their dead, every night offering food to the spirit.

DIALECT

The Yogad dialect resembles quite closely Ibanag and Gaddang. Malumbres [4] states that the Yogad dialect is but modified Gaddang. The Yogads have a peculiar intonation in speaking. They say their prayer in Ibanag. They have no printed literature or periodicals.

It has been observed that the majority of the Philippine dialects lack labial fricatives.[5] However, this is not true in the case in the Yogad dialect. Like Ibanag and Gaddang, it possesses the surd aspirant *f*, a sound which is very common in this dialect. The original *p* becomes *f* when it is immediately followed by *u*. For example, fire, *afuy;* leg, *uffu;* heart, *futú;* ten, *tafulu.* Judging from the material at hand, the sonant aspirant *v* is not used in the Yogad dialect. The original *b* is persistent. For example; moon, *bulan;* pig, *buhay;* thousand, *taribu.*

[4] Historia de Cagayán. Manila (1918) 14.

[5] Conant, C. E., "F" and "V" in Philippine languages, Philippine Ethnological Publications 5 (1908) 135.

LEXICAL COMPARISON

I have selected some of the commonest terms from the work of Otto Scheerer[6] to show the affinity of the Yogad dialect to its sister groups of dialect.

Common terms showing the affinity of Yogad to Ibanag and Gaddang.

English.	Yogad.	Ibanag.	Gaddang.
sky	langít	langi-t	langit
sun	igao	aggau matá tal lángui-t	sinag
moon	bulán	bulán	bulan
night	gabi	gabí	gafi
star	bitun	bitún	bitun
fire	afuy	afuy	áfuy
water	danum	danúm	dánum
name	ngagan	ngagan	ngan
man	lalaqui	tolay	tolay
father	ama	ama	ama
woman	babai	babay	bafay
mother	ina	iná yéna	ína
brother	oagui	uagui	uaii
head	ulú	ulú	ulu
face	muguing	mutúng	mutung
nose	igung	igung	iyung
mouth	labi	simu-t	labi
lip	bibig	bibíg	bifig
tongue	dilá	jila	dila
tooth	ñgipan	ñgipan	ñgipan
eye	mata	matá	mata
ear	bambang	talínga	layag
neck	lig	bul-lao	lig
heart	futu	futú puto jutú	futu
belly	san	san	san
knee	tud	tuad dulúng	tuud
leg	úffu	uffú	uffu
foot	ták-ki	takké	takki
nail	cucu	cucú	cucu
flower	lap-pao	lappau	lappao
root	gammút	gammu-t	gámut
dog	atú	itu kitu	átu

[6] Scheerer, Otto, the Batán dialect as a member of the Philippine group of languages, Philippine Ethnological Publications 5 (1908) 22.

Common terms showing the offinity of Yogal to Ibanag and Gaddang—Ctd.

English.	Yogad.	Ibanag.	Gaddang.
egg	ilug	il-lug	iluk
fish	ikán	sirá	sira
pig	babúy	babuy	bafuy
goat	gánding	kajjing	ganding
snake	irao	iráu	irao
deer	út-ta	uttá	ut-ta
house	binalai	baláy	bálay
bridge	taletai	talétay balatay	tét-ay
hunger	bisin	bisin	bisin
thirsty	nauwa-wan	pangál	nauwa-wan
sickness	taquit	takí-t	taquit
one	inté	tádday	tátta
two	addué	duá	ádua
three	tal-lu	tal-lú	tallú
four	appát	appá-t	appat
five	limá	lima	lima
six	an-nám	annám	annám
seven	pitú	pitú	pitu
eight	oalú	oalú	uálu
nine	isiám	siám	isiam
ten	táfulu	mafulú	tafúlu
eleven	táfulu tatta	karattadday	tafúlu tátta
twenty	aduáfulu	duá fulu	aduáfulu
one hundred	tágatut	magatú-t	tátut

From the common terms mentioned above, it is evident that the Yogad dialect closely resembles Ibanag and Gaddang. In Yogad and Ibanag the accent appears frequently on the second syllable of the word. For example:

English.	Yogad.	Ibanag.
moon	bulán	vulán
star	bitún	bitún
head	ulú	ulú
heart	futú	futú
root	gammút	gammú-t
four	appát	appá-t
seven	pitú	pitú

Words not marked by an accent, are pronounced as in Yogad and Ibanag. For example:

English.	Yogad.	Ibanag.
belly	san	san
nail	cucu	cucu
hunger	bisin	bisin

In the Gaddang dialect the accent frequently appears on the first syllable of the word. For example:

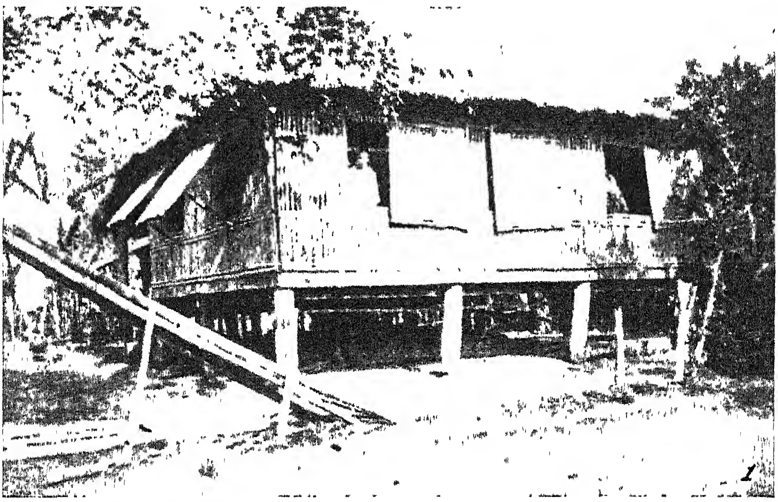
English.	Gaddang.
fire	áfuy
man	tólay
child	ánac
head	úlu
eye	máta
leg	úffu
nail	cúcu
dog	átu
fish	síra
bridge	tétay
sickness	táquit
one	táta
two	ádua
seven	pítu
one hundred	tátut

It is evident that the Yogad and Ibanag dialects have the same intonation in speaking, while that of the Gaddang is different.

SUMMARY

The Yogads belong to the group of Ibanag emigrants who settled in Isabela Province to improve their economic life. Their physical characteristics resemble those of the Christian Gaddangs living in Magat River Valley. Their social life is quite distinct, for they retain many of their primitive customs and beliefs. Their dialect resembles quite closely the dialect groups spoken in Cagayan Province, the home of the Ibanag people.

ILLUSTRATIONS



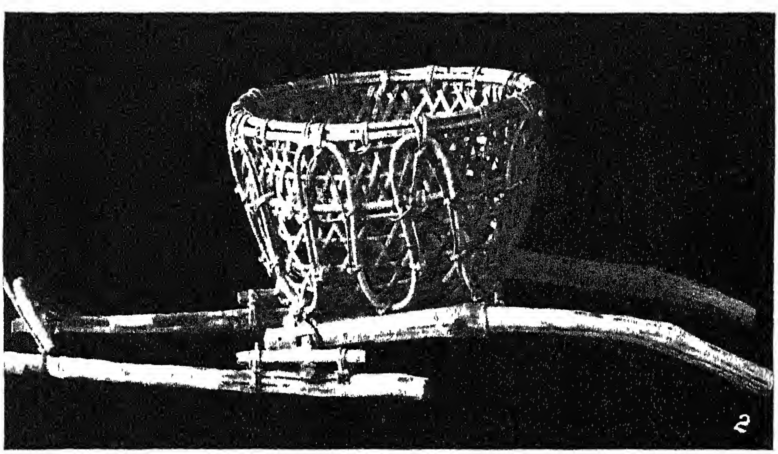


PLATE 1.

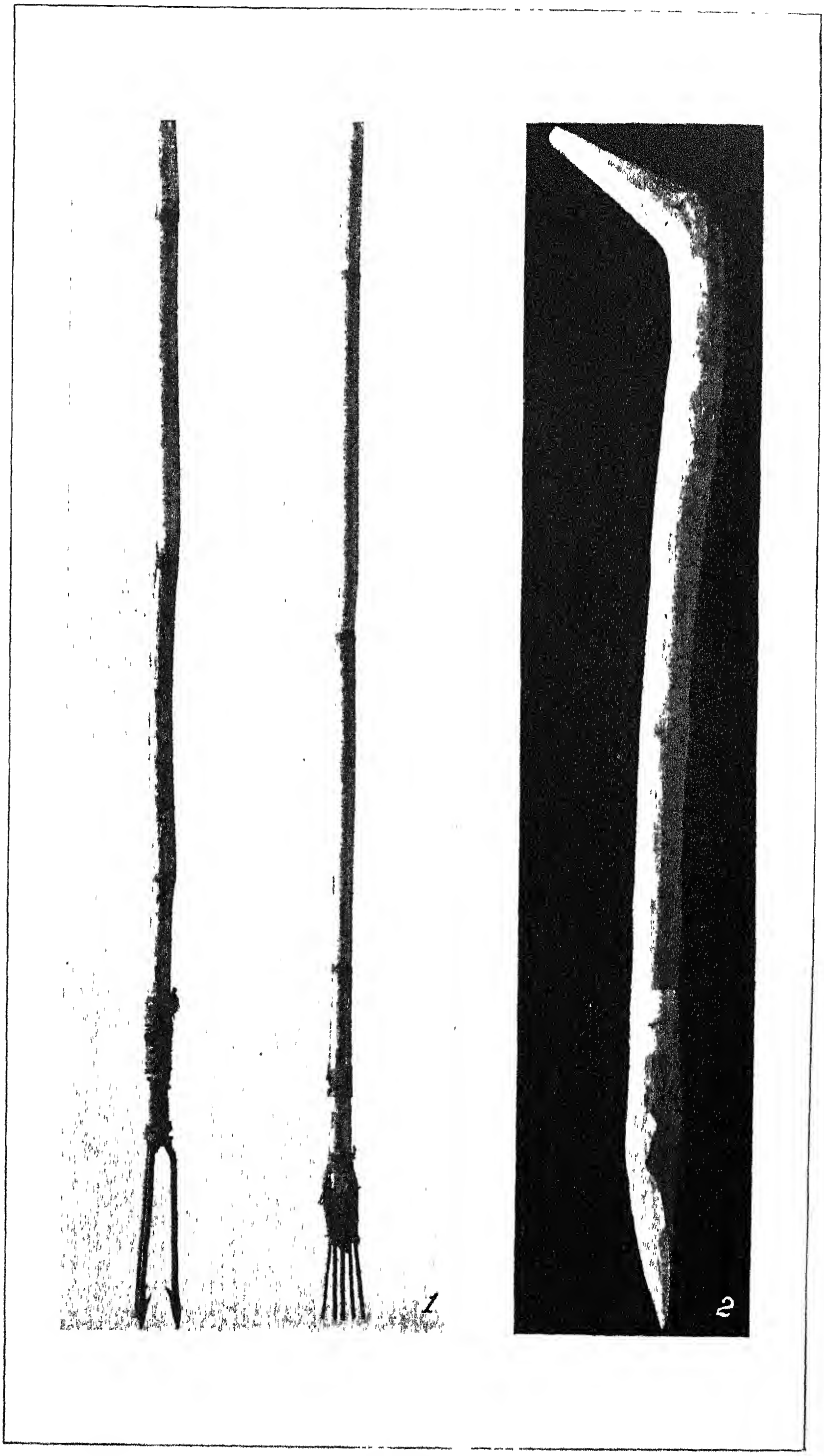
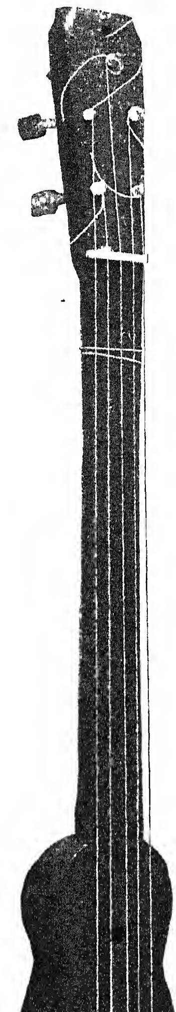


PLATE 2.

1



2

PLATE 3.

NEW BIRDS FROM NORTHERN LUZON, PHILIPPINE ISLANDS

By CANUTO G. MANUEL

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ONE PLATE

Two birds in the ornithological collection of the Bureau of Science attracted my attention. One proved to be a new subspecies of *Cyornis*. The other is a female of *Prionochilus anthonyi* McGregor; the type of this dimorphic species is a male.[1]

CYORNIS BANYUMAS MCGREGORI subsp. nov. Plate 1.

Type—Female, No. 13347 Bureau of Science collection; Mount Cresta at 800 meters, Cagayan Province, Luzon, Philippine Islands, April 6, 1929; collected by Francisco Rivera.

Subspecific characters.—Upper surface resembling that of *C. lemprieri* (Sharpe), of Palawan, Balabac, and the Calamianes, more than that of any other species. However, the brownish olivaceous[2] tinge is more uniform throughout the upper surface than in *C. lemprieri*. Color of underparts distinct from that of *C. lemprieri* in not having white on chin and possessing lighter orange-buff on throat and upper breast. This subspecies also differs from *C. lemprieri* in the length of wings and tail. The remaining four complete feathers of the mutilated tail are shorter than any of the tail feathers of *C. lemprieri* from Puerto Princesa and Tanabog, both in Palawan, that were examined.

This subspecies differs from *C. beccariana simplex* Blyth of Luzon and Marinduque in having no blue on the upper parts. Robinson and Kinnear[3] however, are of the opinion that the blue color of the upper surface shows a "considerable general variation." Tawny-olive band on forehead absent in *C. b. simplex*. Undersurface distinctly lighter.

In accordance with the characters laid down by Chaseen and Kloss[4] for the *banyumas* group, "*crown and back brown, or*

[1] Philip. Journ. Sci. § D 9 (1914) 531.

[2] Colors are from Robert Ridgway, Color Standards and Color Nomenclature. Washington (1912).

[3] Nov. Zool. 34 (1928) 231–261.

[4] Bull. Raffles Mus. No. 2 (1929) 23–42.

grey-brown, in females; tail either brown or particolored blue and brown," this bird is considered a new form of this group with its range in the highlands of northern Luzon.

Description.—A band of tawny-olive on forehead, which gradually disappears over each eye; crown and hind neck deep grayish olive; back and greater coverts dark citrine, basal half of these feathers grayish brown; rump[5] dark citrine; upper tail coverts Sudan brown; tail Sanford's brown; primaries and secondaries blackish brown, their outer webs with snuff brown edges; tertiaries olive-brown. Chin, throat, and fore breast orange-buff, becoming brownish buff on breast; abdomen with a circular patch of grayish white, about 20 millimeters in diameter; flanks dark citrine. Under tail coverts (mutilated) grayish white. A pair of loral bristles white.

Wing, 78 millimeters; culmen from nostril, 11; tarsus, 18.

This subspecies is named for Mr. Richard C. McGregor, ornithologist of the Philippine Government, who, for the last thirty-three years, has contributed much to the knowledge of the Philippine avifauna.

PRIONOCHILUS ANTHONYI McGregor.

Type of female.—No. 28514 Bureau of Science collection; Mount Tabuan, at about 1,500 meters, Cagayan Province, Luzon, Philippine Islands, May 18, 1929; collected by Francisco Rivera.

Entire upper surface and sides of head olive-green, which is more intense on back, rump, and upper tail coverts. Primaries and secondaries dark brown with little olivaceous gloss. Outer webs of quills with olive-green margins, those of the inner webs light brown. Primary coverts dark brown, other coverts olive-green. Chin sparsely covered with antrorse white feathers; throat gray; sides of breast yellowish citrine; sides of abdomen and thigh olive lake; a line of primuline yellow along middle breast and abdomen, including entire under tail coverts.

Bill black above and matt ivory yellow below; legs, feet, and claws Brussels brown; soles pale yellow, same as in male.

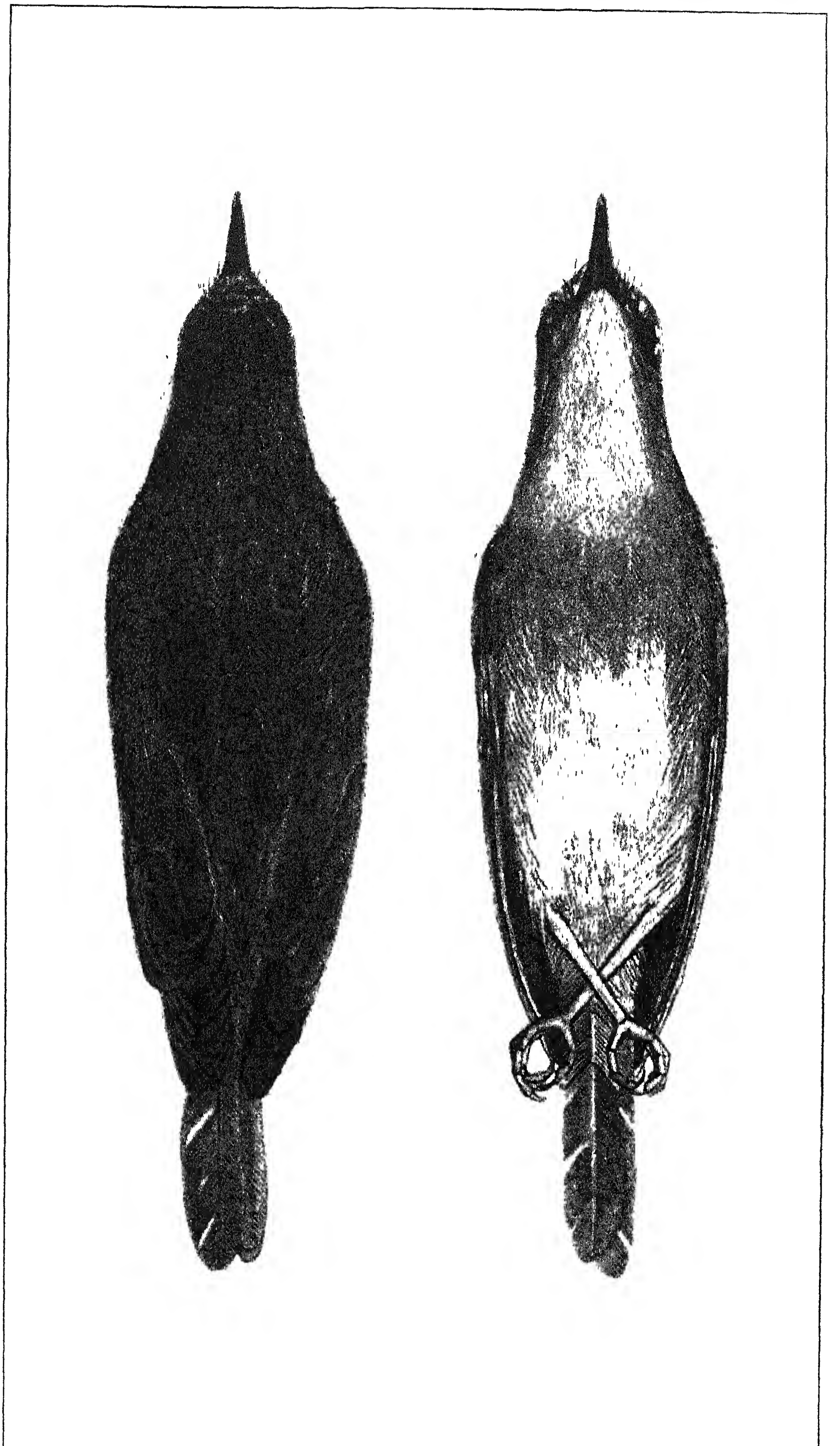
Length, 87 millimeters; wing, 59; culmen, 10; tail, 29; tarsus, 16.

The mate (Bureau of Science collection, No. 28513) of this female was also obtained.

[5] Parts are mutilated.

ILLUSTRATION

PLATE 1. *Cyornis banyumas mcgregori* subsp. nov., female.



THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 56 FEBRUARY, 1935 No. 2

NEW OR INTERESTING PHILIPPINE FERNS, VIII [1]

By E. B. COPELAND

Of the Philippine Department of Agriculture and Commerce, Manila

FOURTEEN PLATES

OPHIOGLOSSUM RAMOSII Copeland sp. nov. Plate 1, figs. 1 and 2.

O. simplici simile, majus; caule parva, ut videtur subterranea; frondibus solitariis vel 2–3 fasciculatis, usque ad 45 cm altis et 4 cm latis sine discrimine stipitis et laminae, vestigio segmenti sterilis nullo vel dubio; spica apicale, 5 cm longa, 5 mm lata, lanceolata, sporangiis lateralibus, haud interruptis, parvis.

CAMIGUIN (Mindanao), Mount Mahinag, in mossy forest; *Bu. Sci. 14771 Ramos,* April, 1912.

This remarkable plant has been held unnamed long enough, in the hope of more ample collection. It is now a pleasure to give it the name of its discoverer, Maximo Ramos, who lost his life in the field, May 8, 1932, after nearly thirty years of zealous and productive botanical collecting for the Philippine Government.

CYATHEA BIPINNATIFIDA Copeland sp. nov. Plate 2.

Trunco ignoto; stipite 15 cm longo, gracile, deorsum paleis 5–12 mm longis basi ultra 1 mm latis apice setaceis fulvo-griseis iridescentibus vestito, sursum pilis fulvis 3 mm longis dense vestito; fronde 25 cm longa, 10 cm lata, acuminata, basi truncata, bipinnatifida, pinnis infimis subdeflexis, rhachi setosa setis basi incrassatis; pinnis sessilibus, lineari-ellipticis, majoribus 5 cm

[1] The seventh paper with this title appeared in Philip. Journ. Sci. 40 (1929) 291–315.

longis 1 cm latis, obtusis vel acutis, basi truncatis, pinnatifidis, costis setis deorsum dense et squamulis paucis subbullatis apiculatis intersparsis vestitis; segmento infimo pinnarum inferiorum fere libero late elliptico, aliis late oblongis, 3 mm latis, subfalcatis, apice late rotundatis, integris, herbaceis, glabris; venis ca. 4-paribus, simplicibus; soris medialibus, indusiis ut videtur carentibus.

BASILAN, east of Cumalarang River, *Bu. Sci. 16208 Reillo*, September, 1912.

This fern has spent the past two decades among the undetermined specimens of *Dryopteris*. The paleæ are those of *Cyathea*, and the sporangia fix its position there; but I know no related species.

CYATHEA UMBROSA Copeland sp. nov. Plate 3.

Stipitis basi paleis nitidis aut albidis aut laete fulvis usque ad 5 cm longis et 4 mm latis apice in setam longam setuliferam aut albam aut brennescentem protensis; pinna longe (8 cm) stipitulata, 75 cm longa, fere 30 cm lata, rhachi haud dense tuberculata, fere glabra; pinnulis permultis, infimis solummodo pedicellatis, usque ad 15 cm longis, 22 mm latis, serrato-acuminatis nisi apices versus pinnatis, costis inferne squamulis albis integris plerisque ovatis 1 mm longis sparsis ornatis; pinnulis " integris, acutis, plerisque curvis, papyraceis, inferne glaucis, costulis minute et sparse squamuliferis; venis inferne conspicuis, plerisque bis furcatis; soris inframedialibus, nudis, apices versus carentibus.

LUZON, Sorsogon Province, Mount Bulusan, *Elmer 16588*, July, 1916.

This was distributed with my identification as *C. lepifera*, but new study satisfies me that it is too distinct to justify this. It is distinct in ampleness of frond, in thinness, in glaucousness, and particularly in nakedness.

Elmer 17070, from the same place, conforms satisfactorily to our cotype of *C. lepifera*, from the same general area. It is like it in denseness of tubercles and paleæ, and in firmer texture, but is more ample. The paleæ of the base of the stipe are golden in mass color, each being bordered by a narrow dark-golden line.

CYATHEA PTERIDIOIDES Copeland sp. nov. Plate 4.

Trunco 3.5 m alto, stipite ignoto, fronde 1 m (vel ultra) longa, 70 cm lata, rhachi dorsum 1 cm crassa sub paleis imbricatis late lanceolatis 1 cm longis albidis vel medio laete rufis dense fur-

furacea, sursum inferne tuberculis globosis nitentibus 0.5 mm diametro horrida, apicem versus rhachibusque pinnarum squamis tenuissimis ovatis laceris albidis profunde immersis; pinnis stipitulatis medialibus 35 cm longis, abrupte brevi-acuminatis, pinnulis contiguis, subsessilibus, 10 cm longis, basi 18 mm latis, acuminatis, deorsum pinnatis, costis deorsum inferne dense paleaceis, sursum nudis, pinnulis ^{II} resp. segmentis 3 mm latis, obtusis marginibus integris revolutis, costulis deorsum paleatis, venis inferne praestantibus, furcatis, lamina nuda, rigide chartacea; soris inframedialibus, paleis protectis, indusiis nullis.

PANAY, Antique Province, Culasi, altitude 1,500 meters, *McGregor 6061*, June, 1918.

The color, texture, and dissection give the herbarium specimen the appearance of *Pteridium*. Another representative of the small group of species known by the Javan *C. tomentosa*, *C. crinita* of Ceylon, and *C. lepifera* of Luzon (Camarines Sur): like the last in texture, but with broader pinnules and segments, less completely tripinnate, much scalier on the major axes, and naked toward all apices.

DRYOPTERIS SQUAMIPES Copeland sp. nov. Plate 5.

Dryopteris D. viscosae affinis pinnis deorsum sensim decrescentibus; caudice erecta, valida, breve; stipitibus dense fasciculatis, 5–7 cm altis, pervalidibus, atropurpureis, paleis ovatis acuminatis 5 mm longis fuscis dense vestitis; fronde 25–35 cm alta, media altitudine 6 cm lata, acuminata, deorsum longe attenuata, vix bipinnata, rhachi ubique dense ferrugineo-pilosa deorsum quoque inferne squamosa; pinnis medialibus 3 cm longis, subsessilibus, basi 1 cm latis, acutis, vix ad costam pinnatifidis, costa superne brevisetosa, inferne et pilis et paleis minutis angustis obsita; segmentis ellipticis, apice rotundatis, crenulatis, utraque facie sparse piluliferis, atroviridibus, in herbario papyraceis; venis ca. 5-paribus; soris magnis, 3- vel 4-paribus, faciem inferiorem fere obtegentibus, indusio persistente, fulvo, suborbiculare vel elongato, bullato, nudo.

MINDANAO, Bukidnon Province, Mount Lipa, *Bu. Sci. 38525 Ramos and Edaño*, "on dry, mossy forest near summit, altitude 6,600 feet."

In form of frond like many species of cooler lands, relatives of *Thelypteris;* but more nearly related, I believe, to *D. viscosa*. Growth on an exposed mountain top might cause that species to produce shorter, stouter, and more scaly stipes, but could hardly

be responsible for the gradual dwarfing of the lower pinnæ. Four or more pairs of these are deflexed, and the lowest may be 15 mm long.

DRYOPTERIS PRESLII Christ.

Dryopteris Preslii CHRIST, in Philip. Journ. Sci. § C 2 (1907) 214, *non* (Baker) O. K.

I have already [Philip. Journ. Sci. 40 (1929) 294] called attention to Christ's misinterpretation of this species, and am now able to place the plant he had in hand, *Cuming 354* from Bohol as represented in the Philippine National Herbarium. This is a dwarf specimen of *Dryopteris dissecta* (Forster) O. K., the largest fronds 6 by 4 cm, undissected in correlation with its size, but fertile. There is no uncertainty as to the affinity, and I am not now disposed to construe it as genetically distinct. Another dwarf, less certainly representing *D. dissecta*, is *Bur. Sci. 41134 Ramos*, Coron Island, Palawan. The specimens of *Cuming 354* in other herbaria, called *Lastraea spectabilis* Presl, Epim. 38, *D. syrmatica*, etc., must be very unlike ours.

It may be observed that, if the species be construed closely, several are included under *D. dissecta*. The typical Polynesian plant has pubescent veins and almost naked lamina, the veinlets usually anastomosing here and there.

DRYOPTERIS LASERPITIIFOLIA (Scort.) C. Christ.

Dryopteris laserpitiifolia (Scort.) C. CHR.

MINDANAO, Cotabato Province, Guinatilan, altitude 800 meters, *Copeland s. n.*, September, 1933, in wet woods. Conforms to Beddome's description (Suppl. 84), except for being smaller throughout—fronds about 20 cm long on 10- to 20-cm-long stipes, the latter brownish. Only two plants were collected—not enough for a final judgment as to eventual size. No similar species has been known here previously.

DRYOPTERIS PHILIPPINENSIS (Baker) Copeland nov. comb.

Nephrodium philippinense BAKER, Ann. Bot. 5 (1891) 327.
N. caudiculatum J. SM., Journ. Bot. 3 (1841) 411, *nomen.*
N. extensum HOOKER, Sp. Fil. 4: 72 *partim, non* Blume.
Dryopteris basilaris C. CHR., Index (1905) 254; CHRIST, Philip. Journ. Sci. § C 2 (1907) 196.
Nephrodium basilare PRESL, Epim. (1849) 258, *nomen.*

These names are all based on *Cuming 10, 84,* and *338*, as listed by Baker, who seems to have been the first to provide a diagnosis for this locally common species. Christensen rejected

Baker's name because of the earlier described *Phegopteris philippinensis* Mett., *Gymnogramme philippinense* Fée, Genera 181; but this does not bar the transfer of Baker's name, because it has not itself been transferred to *Dryopteris;* also, because, I suppose, it is not a *Dryopteris* anyway, but is *Heterogonium aspidioides* Presl, although Fée and Mettenius cite *Cuming 321,* which I have not seen, and Presl cites *Cuming 295.*

The diagnoses of Baker and of Christ are alike essentially wrong in one respect—if our *Cuming* plants and theirs are alike: the plant is not glabrous. *Cuming 84,* represented by two sheets in hand, is very evidently pubescent on rachis, costa, and veins, with setulose upper surface, particularly near the margin. *Cuming 10,* the type collection, is an older specimen, and might be called glabrescent in anticipation, but no part is really glabrous; the secondary vein, running to the sinus, is most persistently bristly. *Cuming 338* is intermediate in hairyness. Of the more recent collections cited by Christ, *Topping 407* and *Copeland 204* are most conspicuously hairy. *Copeland 637* has really naked pinnæ, but is not this species. *Cuming 10* and *84* are exceptionally large. It is a common fern along streams at minor altitudes from Cagayan, Luzon, to Zamboanga, Mindanao, but is not reported elsewhere.

DRYOPTERIS DIVERSIFOLIA (Presl) Christ.

Dryopteris diversiloba (Presl) CHRIST, in Philip. Journ. Sci. § C 2 (1907) 199.

Besides the original collections, *Cuming 51* and *102,* the only entirely typical distributed collection I know is *Bur. Sci. 23169 McGregor,* from Laguna, near the Tayabas boundary. It occurs, however, on Maquiling. Now, this is the type locality of *D. acromanes* Christ, t. c. 200, whence it has been distributed by *Topping,* his *735.* The supposed differences are that the latter has the pinnæ more enlarged toward their apices, and the sori confined to the lobes. I believe that they are one species.

It is noted that Christ published the name *D. diversiloba* in proper binomial form, but as a subspecies of *D. canescens;* and that under it he listed a variety *acrostichoides* (no specimens cited here) with two subvarieties, *rhombea* and *lancea.* Both of the latter seem to me best to be regarded as species. There is never any difficulty in distinguishing either from *D. diversiloba,* and, while they are sometimes found together, it is almost always easy to refer each individual to one or the other.

DRYOPTERIS RHOMBEA (Christ) Copeland comb. nov. Plate 6.

Dryopteris diversiloba var. *acrostichoides* subvar. *rhombea* CHRIST, Philip. Journ. Sci. § C 2 (1907) 200.

Nephrodium acrostichoides J. SM., *nomen, non* Michaux.

Pronephrium acrostichoides PRESL, *non Dryopteris acrostichoides* O. K.

The type is *Cuming 149* in the Philippine National Herbarium, which Christ had on loan when he applied the name. The species ranges from Nueva Vizcaya (*Merrill 162*, cited by Christ, t. c. 199, as *D. diversiloba*) to Mindanao. It is very common at low to medium altitudes, and assumes bizarre forms in all such places. Representative distributed collections are LUZON, Bataan, *Copeland P. P. E. 18, Leiberg 6153, Merrill 3130:* Laguna, *Elmer 18205, For. Bur. 9550 Curran, Bur. Sci. 23167 McGregor:* Tayabas, *Topping 1306:* Camarines Sur, *Bur. Sci. 75790 Edaño.* LEYTE, *Bur. Sci. 41756, Edaño.* MINDANAO, Surigao, *Bolster 252;* Agusan, *Elmer 13271, Merrill 7333, Weber 1178:* Davao, *Copeland 503, 698:* Lanao, *Clemens 1078:* West Misamis, *For. Bur. 4613, 4710 Mearns and Hutchinson:* Zamboanga, *Copeland 1547, 1754, 1774.*

It differs from *D. diversiloba* (Presl) Christ in not being deeply nor at all regularly lobed. Only in the bizarre forms there are some long lobes, sometimes about the middle of the pinnæ, more commonly nearer their apices. The sori are usually round, but may tend to run together in pairs. Indusia may be wanting on herbarium specimens, but are present, and naked, on young sori. I have suspected that this might be *Goniopteris asymmetrica* Fée, as Christ once determined it for me, but have concluded that that must be a synonym of *D. diversiloba;* not only is it based on the same two collections, but it is described as with *frondibus pinnato-pinnatifidis.*

DRYOPTERIS LANCEOLA (Christ) Copeland comb. nov. Plate 7.

D. diversiloba var. *acrostichoides* subvar. *lanceola* CHRIST, Philip. Journ. Sci. § C 2 (1907) 200.

The type is *Copeland 250*, from Mount Mariveles. Other distributed collections are LUZON, Cagayan, *Weber 1550:* Nueva Vizcaya, *Bur. Sci. 14295 McGregor: Zambales, For. Bur. 5830 Curran:* Bataan (Mount Mariveles), *Williams 208:* Rizal, *Bur. Sci. 986, 1807 Ramos, Topping 633, 754, 897:* Laguna, *Bur. Sci. 9714 Robinson.* NEGROS, *Whitford 1600.* MINDANAO, Surigao, *Bolster 261, Wenzel 2617.*

This species is much more uniform than is *D. rhombea*, varying only moderately in the degree of contraction of the fertile frond, and within fairly narrow specific limits in other respects.

DRYOPTERIS MAQUILINGENSIS Copeland sp. nov. Plate 8.

D. rhombeae affinis pinnis majoribus haud apices versus dilatatis; rhizomate repente, paleis fuscis parvis late lanceolatis acuminatis vestito; stipitibus arcte approximatis, stramineis setulis albidis pubescentibus demum glabrescentibus, frondium sterilium 5–10 cm, fertilium 20–30 cm altis; fronde pinnata, sterilis parte apicale 7–15 cm longa, 3–4 cm lata acuminata basi truncata, obscure vel grosse serrata pinnis lateralibus ca. 2-paribus 4–6 cm longis 2–2.5 cm latis falcato-acuminatis basi subcordato-truncatis plerumque integris carnoso-subcoriaceis, fertilis parte apicale 6–9 cm longa basi 3 cm lata deinde ad apicem acutam angustata, dentata vel basin versus inciso-dentata, pinnis lateralibus ca. 3-paribus infimis ca. 4 cm longis vix 2 cm latis plerumque undulato-crenatis; axibus minute pubescentibus; soris primo globosis, longitudinaliter seriatis; demum subconfluentibus, indusiis vestigialibus et mox evanidis.

LUZON, Mount Maquiling, altitude 350 meters. Type in Philippine National Herbarium, *Copeland*, November 1932, numero nondum praeditus, in Pterid. Philip. Exsic. distribuendum; ibid., *Elmer 18169*.

While this is a relative of *D. rhombea*, I cannot bring it within the range of that very variable species. Beside the difference in form of pinnæ, obvious in dried specimens, it is in nature distinct in texture and color, being thicker and darker. Herbaria which have Elmer's Maquiling plants may compare his *18205*, which is typical *D. rhombea*, and *18169*, which in the Philippine National Herbarium is sterile *D. maquilingensis* with very long stipes. Except in the degree of dimorphism, *D. maquilingensis* seems to be fairly uniform—for its group.

ATHYRIUM ELMERI Copeland.

Athyrium Elmeri COPELAND, Elmer's Leaflets 2 (1908) 399; Philip. Journ. Sci. § C 3 (1908) 285. Described from Negros.

To this, I refer a plant from the west base of Mount Apo, Guinatilan, Cotabato, altitude 900 meters, in very wet forest, *Copeland*, September, 1933, with freely and sharply incised pinnules. Whether this and the Negros plant are identical or not,

they are closely related, as shown by the common possession of dark-margined and toothed brown paleæ, not noted in the original description.

LOMARIOPSIS PAPYRACEA Copeland sp. nov. Plate 1, fig. 3.

Rhizomate scandente, 7 mm crasso, apice paleis castaneis lanceolatis attenuatis 6 mm longis vestito, deorsum glabrescente; frondibus plantae juvenilis simplicibus usque ad 30 cm longis, 4 cm latis, caudatis, basi longe attenuatis, stipite 10–15 cm longo, plantae normalis pinnatis, stipite 10–25 cm longo, pinnis 7-paribus vel pluribus, articulatis, subsessilibus, 15–18 cm longis, 4 cm latis, apice abrupte caudatis cauda 10–15 mm longa, basi inaequilateraliter cuneatis, papyraceis, venis conspicuis; fronde fertile 20–30 cm longa stipite incluso, pinna apicale 6–7 cm longa, 16 mm lata, lateralibus paullo minoribus.

MINDANAO, Davao Penal Colony, *Copeland*, August 30, 1932, in low, wet woods. Type in Philippine National Herbarium. Only one fertile frond found with pinnæ still present.

Related to *L. Smithii*, but distinguished by the subsessile pinnæ and the small fertile fronds with broad pinnæ. This would be identified more reasonably as *L. cochinchinensis*, from which it differs in general in the same respects. That species has not been reported from the Philippines. It might reasonably be expected in Mindanao; but I have thought it more reasonable to describe the plant in hand as new, than to report an extension of range on the strength of a very aberrant specimen; *L. subtrifoliata*, also described from Mindanao, is too different in texture to invite comparison.

DENNSTAEDTIA SCANDENS (Blume) Moore.

Hypolepis repens J. SM., *non* Presl.

Saccoloma moluccanum C. CHR., Index 372, as interpretation of *H. repens* J. Sm.

Hypolepis nigrescens HOOKER, Sp. Fil. 2: 66, as to the Luzon plant.

The plant in question is *Cuming 271*, of which we have two ample sheets, sterile, but unquestionably *D. scandens*. The spiny axes, which must have been responsible for Smith's wrong identification, as well as for Hooker's, make it impossible that they had *Ithycaulon* (*S. moluccanum*) in hand. *Dennstaedtia scandens* is a rare species in the Philippines, collected only five times in the last thirty years.

POLYPODIUM APOENSE Copeland sp. nov. Plate 9.

Rhizomate breve et gracile, inter baseos stipitum paleis paucis minutis fulvis obtusis vestito; stipitibus fasciculatis, filiformibus, 1–1.5 cm longis, glanduliferis; fronde 3–4 cm longa, 4 mm lata, subpinnata, tenuiter herbacea, ubique (inferne densius) pilis minutis claviformibus nitidis plerisque bicellularibus vestita; segmentis oblongis, ca. 1.2 mm latis, patentibus, obtusis vel subacutis, integris vel sinuatis, monophlebiis; soris basalibus, approximatis et interdum trans rhachin confluentibus.

MINDANAO, Cotabato, Mount Apo, altitude 2,000 meters, *Copeland s. n.*, ad truncos muscosos.

Distinguished from *P. sikkimense* Hieron., *P. pseudotrichomanoides* Hayata, and *P. pulogense* by the pubescence; in this respect like *P. glanduloso-pilosum* Brause, which by description should be firmer in texture and have subtriangular segments.

POLYPODIUM PACHYCAULUM Copeland sp. nov. Plate 10.

Ctenopteris, rhizomate breve, 5 mm crasso, radicibus, basibus stipitum et paleis atrocastaneis 6 mm longis anguste lanceolatis attenuatis irregulariter insigniter ciliatis dense immerso; stipitibus caespitosis, exarticulatis, 1–2 cm longis, rhachibusque atrofuscis, pilis purpureis 1 mm longis vestitis; fronde ca. 10 cm longa, 2–2.5 cm lata, utrinque angustata, coriacea, deorsum pinnata, pinnis in parte superiore decurrenti-confluentibus, erecto-patentibus, integris, 2 mm latis, inferne pilis minutis atropurpureis dense pubescentibus superne subglabris; venis occultis, simplicibus; soris medialibus, superficialibus, demum saepe confluentibus.

MINDANAO, Cotabato, Mount Apo, altitude, 2,000 meters, *Copeland*, September 6, 1932, ad truncos muscosos.

The aspect is that of *P. nutans*, not that of any other species known to me with pubescent surfaces.

GRAMMITIS MICROTRICHA Copeland sp. nov. Plate 11.

Inter G. **pleiosoram** n. comb. [Polypodium, Mett., Linnaea 36 (1869) 128] et G. **sumatranam** n. comb. [Polypodium, Baker, Journ. Bot. (1880) 214], pube stipitis 2 cm longi densa et brevissima, lamina subcoriacea minute pubescente sat dense et brevissime ciliata, ca. 12 cm longa, 10–12 mm lata, crenata, venis pluriramosis immersis, soris superficialibus, globosis, pluriseriatis vel irregulariter sparsis.

MINDANAO, Cotabato, Guinatilan (west base of Mount Apo), altitude 1,000 meters, *Copeland s. n.*, September, 1933, on mossy trunk.

Grammitis sumatrana is found higher on Mount Apo (described there as *Polyp. pleiosoroides*); it is decidedly more coriaceous, less pubescent and with rather longer hairs, and mostly elongate sori or at least receptacles.

LOXOGRAMME MAJOR Copeland sp. nov. Plate 12.

L. parallelae similis quondam eacumque confusa, statura majore costa stipiteque ebeneis distincta, rhizomate valido paleis 3.5–5 mm longis lanceolatis griseo-fuscis acuminatissimis integris vel hinc illinc minutissime spinulosis (parietibus cellularum excurrentibus) vestito; stipitibus 1–5 mm inter sese distantibus, 1–2 cm longis, validis, subapplanatis, ebeneis; fronde plerumque 30 cm longa, 10–12 mm lata (rarius usque ad 50 cm longa), utrinque angustata, costa nigra valida utraque facie applanata; soris 1–4 cm longis, costae fere parellelis, haud imbricatis.

MINDANAO, Cotabato, Mount Apo, altitude 1,800 meters, *Copeland, s. n.*, September 7, 1932.

This is the fern already known from the neighboring Mount Matutum and tentatively reported [Philip. Journ. Sci. 38 (1929) 153] as *L. parallela*. Collecting it again on Apo, and more amply, I find the greater stature to be constant, and that it is further characterized by disproportionately stouter, black stipe and costa.

The Kinabalu (Borneo) species similar in stature has been collected again by *Mrs. Clemens, 28986*. It is subsessile without black axes, in which respects it is like typical *L. parallela*.

GONIOPHLEBIUM TERRESTRE Copeland sp. nov. Plates 13 and 14.

Schellolepis, rhizomate late repente, gracile, 2 mm crasso, paleis castaneis persistentibus 2–3 mm longis apicibus setaceis squarrosis ubique vestito; stipitibus 8–12 cm longis; fronde 20–30 cm longa; pinnis utroque latere 3–5, maximis sterilibus 8 cm longis, 14 mm latis, valde acuminatis, basi subsessile cuneatis, irregulariter serrulatis, herbaceis, plerisque minoribus et angustioribus; venis seriem unam areolarum magnarum, rarius alteram interruptam minutarum includentibus; soris superficialibus, magnis.

LUZON, Mount Maquiling, altitude 500 meters, *Copeland*, December, 1932, ad saxas humidas.

Like *G. persicifolium* in form of pinnæ and superficial sori; distinct from this, and from *Polypodium Koningsbergeri* as de-

scribed, in the usually single row of areolæ. Abundant on one area of wet, sunny cliffs, to which the rhizomes are strictly appressed, fruiting at all seasons. Rare in the same neighborhood on mossy branches.

POLYPODIUM INCURVATUM Blume.

Reported from the Philippines from Mount Apo only, collected there by Warburg, Elmer, and three times by myself. The Apo plant, as represented in our herbaria, is atypical, being less rigidly coriaceous and with less-immersed sori than that of Java; that is, it is less completely different from the probably ancestral *P. taeniatum*.

CERATOPTERIS SILIQUOSA (Linnæus) Copeland comb. nov.

Acrostichum siliquosum LINNÆUS, Sp. Plant. (1753) 1071.
Acrostichum thalictroides LINNÆUS, *ibid.*
Ceratopteris thalictroides BRONGN. [Bull. Soc. Philom. (1821) 186, not seen], BENEDICT, Bull. Torr. Bot. Club 36 (1909) 463.
Ellobocarpus oleraceus KAULFUSS, Enum. (1824) 149.

For the numerous other synonyms see Benedict, loc. cit., and Christensen's Index. I take up the most tenable specific name, not because there is any satisfaction in a change, which there emphatically is not, but because I have material of economic interest to publish on this plant, and do not wish in a paper of essentially economic interest to discuss nomenclature, nor to use a name subject to correction.

ILLUSTRATIONS

[The photographs were prepared by the Bureau of Science. The drawings were mostly made by Alicbusan.]

PLATE 1

FIG. 1. *Ophioglossum Ramosii* Copeland. Type, × 1/2.
2. *Ophioglossum Ramosii* Copeland. Spike, × 1.
3. *Lomariopsis papyracea* Copeland. Pinna, × 1/2.

PLATE 2

Cyathea bipinnatifida Copeland. Type: *1*, Fronds, × 2/5; *2*, pinna, × 4/5; *3*, paleæ, ×1–3/5.

PLATE 3

Cyathea umbrosa Copeland. Type: *1*, Pinnule, × 1; *2*, squamule of costa, × 50; *3*, palea of rachis, × 50; *4*, palea of stipe, × 50.
Cyathea lepifera Copeland. Cotype: *5*, Pinnule, × 1; *6*, squamule of costa, × 50; *7*, palea of stipe, × 50.

PLATE 4

Cyathea pteridioides Copeland. Type: *1*, Pinna, × 1; *2*, scale on costa, × 50.

PLATE 5

Dryopteris squamipes Copeland. Type: *1*, Mounted plant, × 2/5; *2*, pinna, × 6/5; *3*, palea from rachis, × 18.

PLATE 6

Dryopteris rhombea (Christ) Copeland. *1*, Mounted (type) plant; *2*, variability of pinnæ, beginning at top, *Leiberg 6150*, Bataan; *Topping 1306*, Tayabas; *Bur. Sci. 41756*, Leyte; *Bolster 253*, Surigao; *Weber 1178*, Butuan; *Copeland 698*, Davao; *Copeland 1547*, Zamboanga; *Copeland 1774*, Zamboanga; *For. Bur. 4613*, Mount Malindang. All × 7/8.

PLATE 7

Dryopteris lanceola (Christ) Copeland. Type: *1*, Mounted plant, × 0.4; *2*, fertile pinna, × 3.2; *3*, sterile pinna, × 1.6.

PLATE 8

Dryopteris maquilingensis Copeland. Type: *1*, Mounted plant; *2*, pinna, × 1; *3*, scale of rhizome, × 25; *4*, sorus, × 30.

PLATE 9

Polypodium apoense Copeland. Type: *1*, Frond, × 2; *2*, segment, × 5; *3*, fragment, showing trichomes, × 20; *4*, palea, × 60.

PLATE 10

Polypodium pachycaulum Copeland. Type: *1*, Plant before mounting, × 2/5; *2*, sterile fragment, × 4; *3*, fertile fragment, × 4; *4*, palea of caudex, × 20.

PLATE 11

Grammitis microtricha Copeland. Type: *1*, Plant before mounting, × 1/2; *2*, fruiting frond, × 1; *3*, fragment of same, × 2; *4*, hairs on stipe, × 70; *5*, hairs on lamina, × 70.

PLATE 12

Loxogramme major Copeland. Type: *1*, Plant before mounting, × 3/8; *2*, palea, × 20.

PLATE 13

Goniophlebium terrestre Copeland. Type: Plant before mounting, × 1/3.

PLATE 14

Goniophlebium terrestre Copeland. Type: *1*, Normal pinna, × 1; *2*, very broad pinna, × 1; *3* and *4*, palæ, × 30; *5*, fertile fragment, × 1.

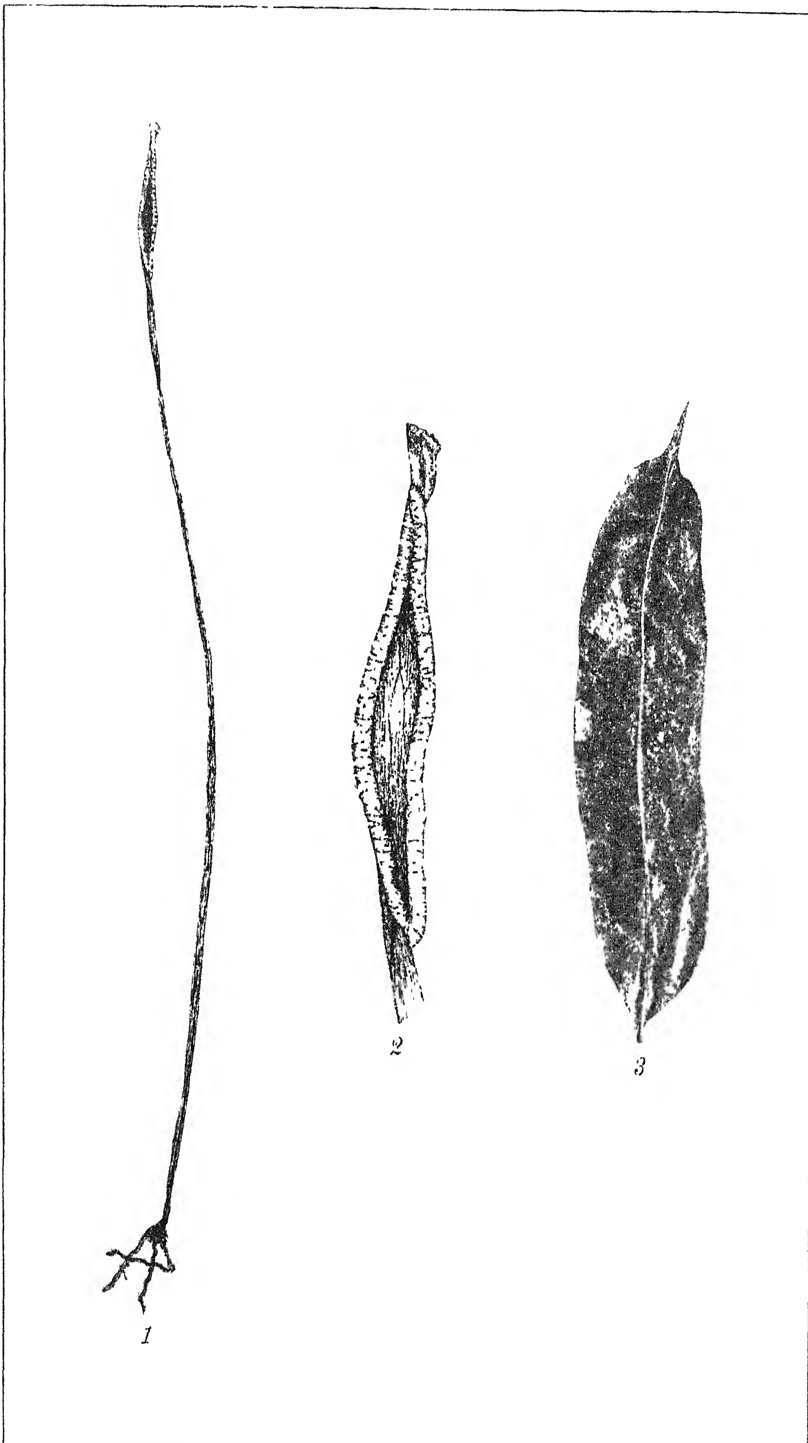
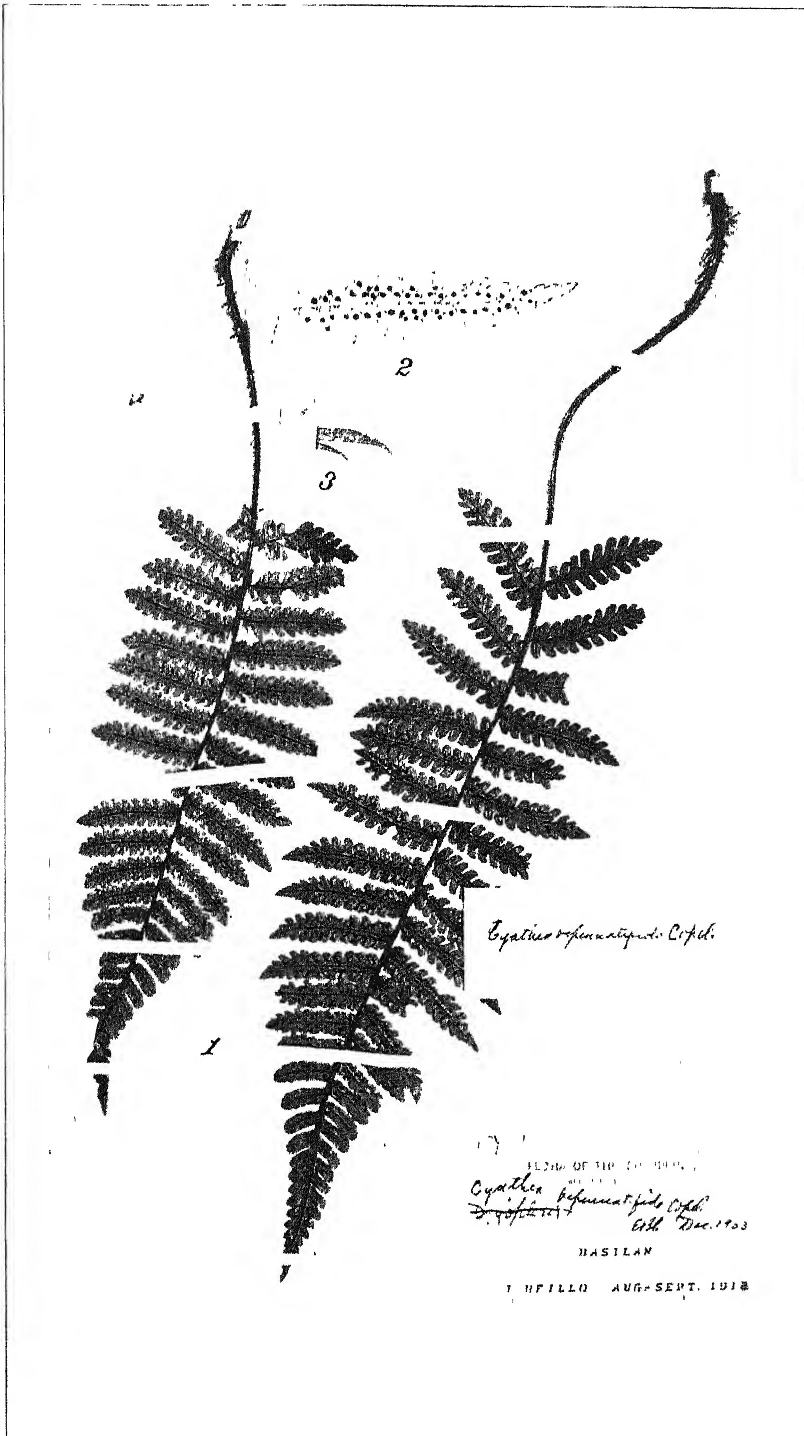


PLATE 1.



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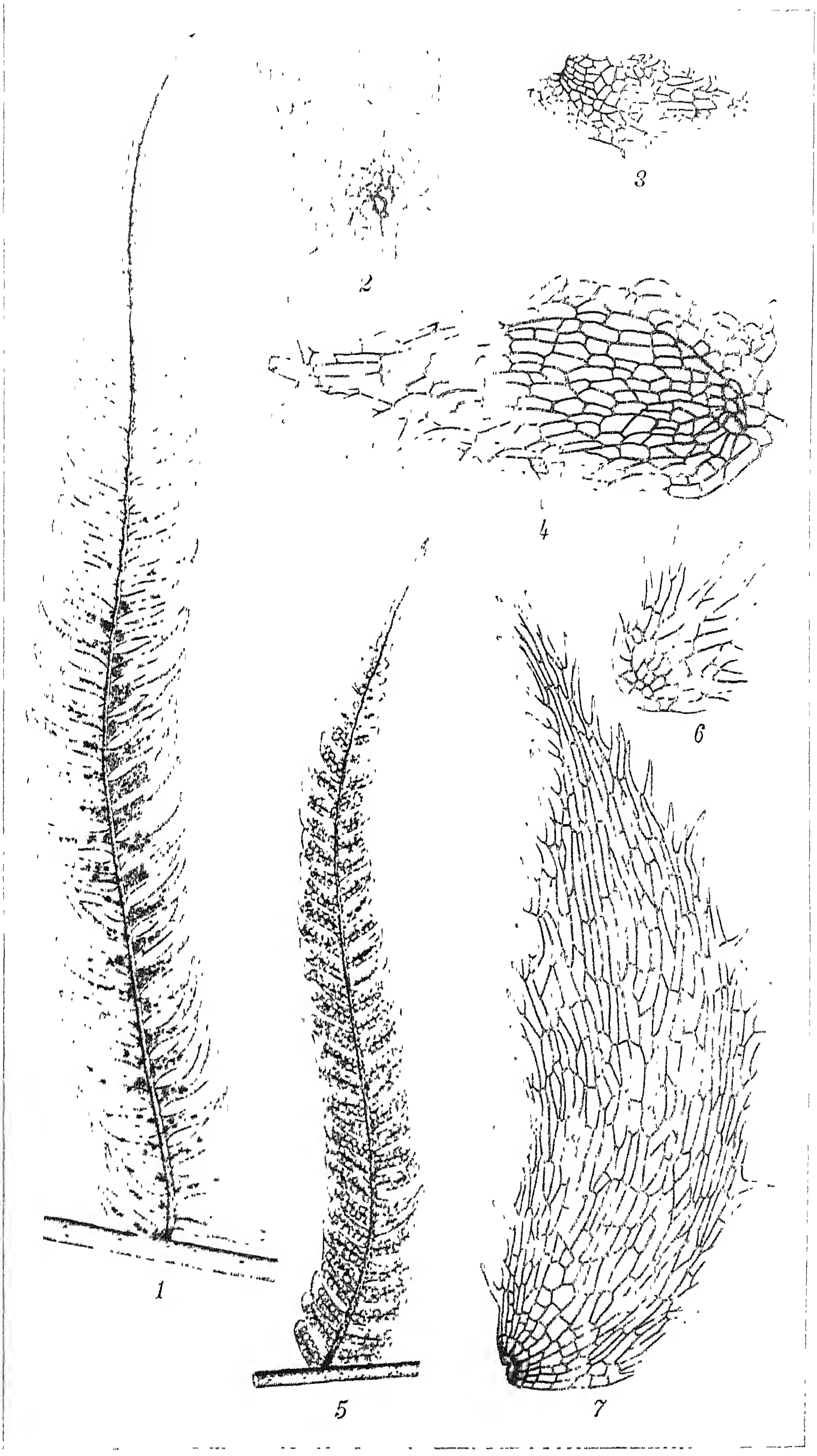

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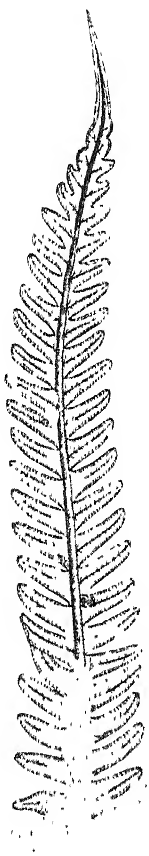

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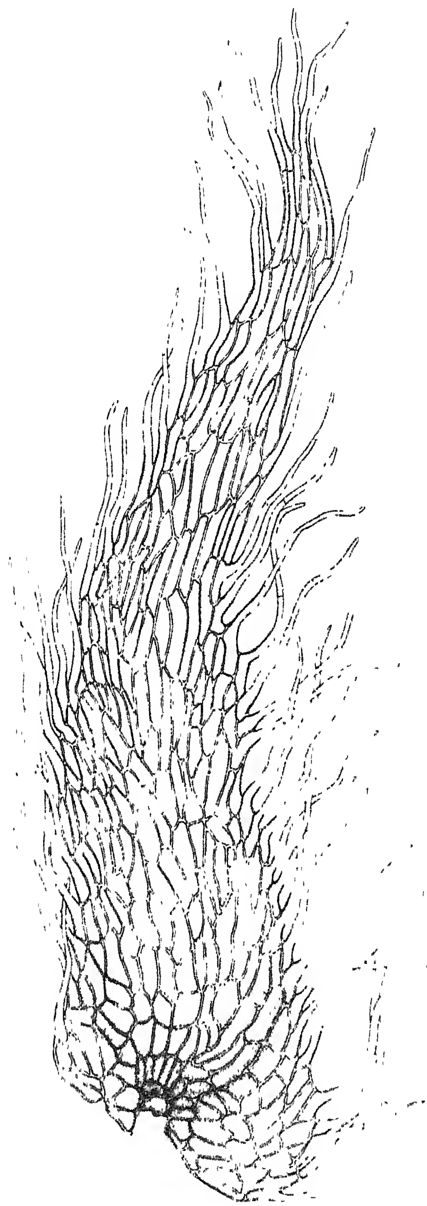

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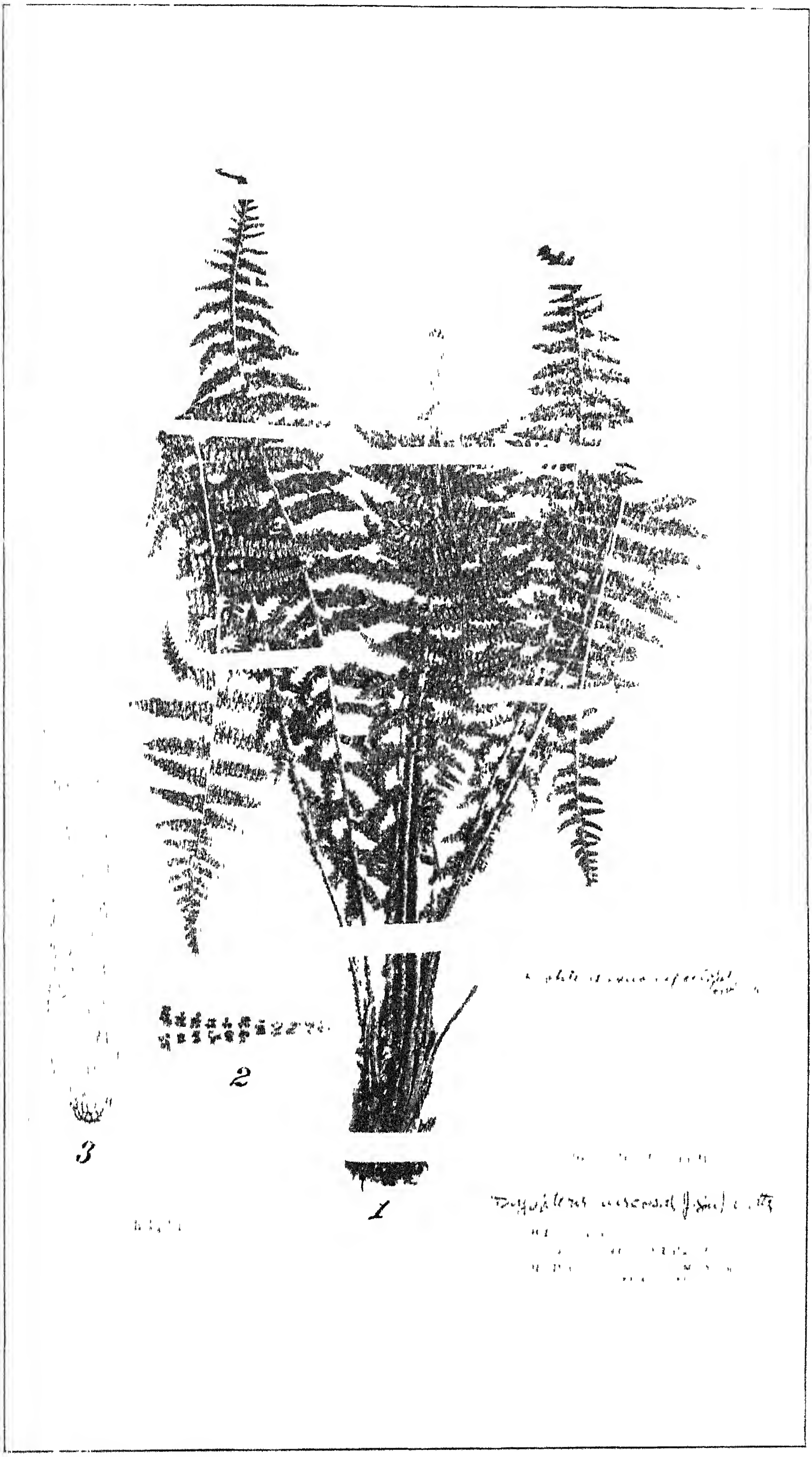
PLATE 4.



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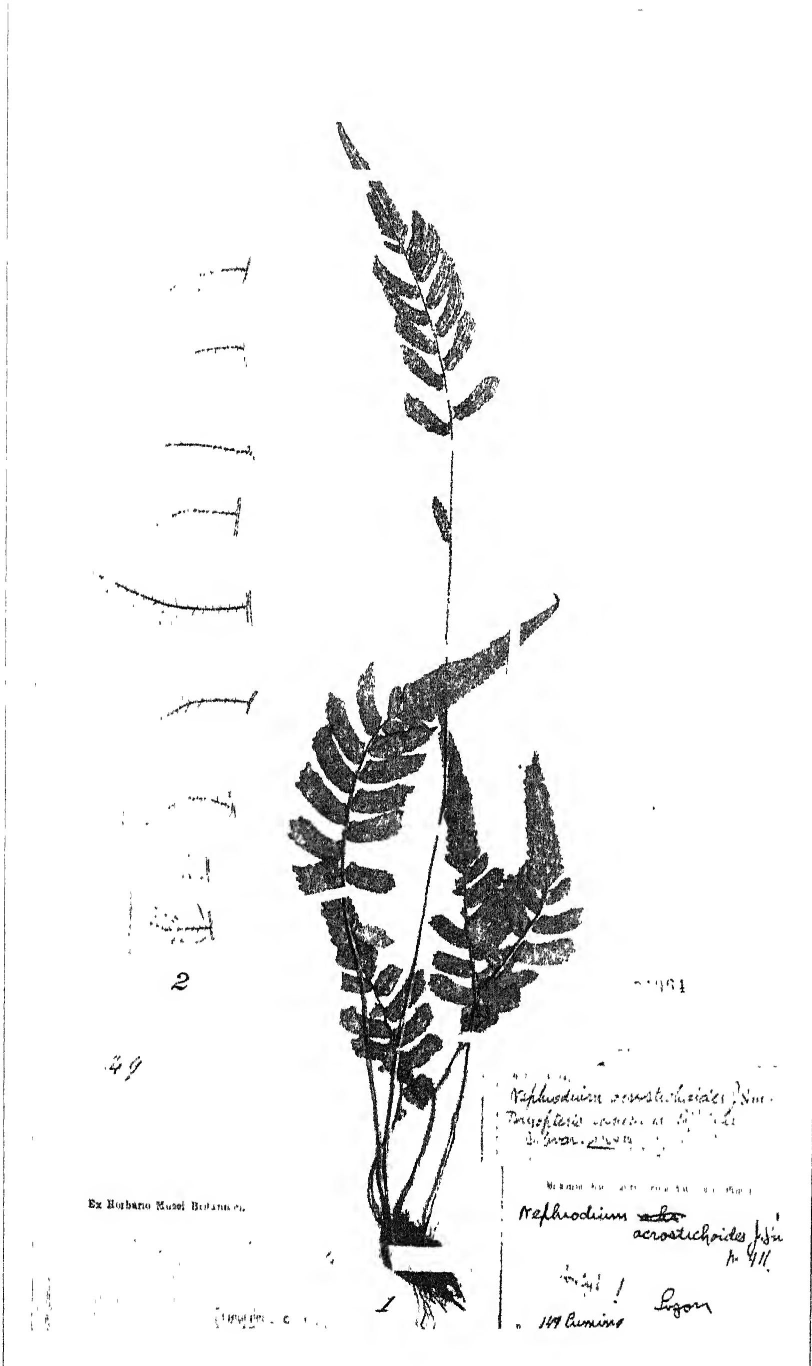
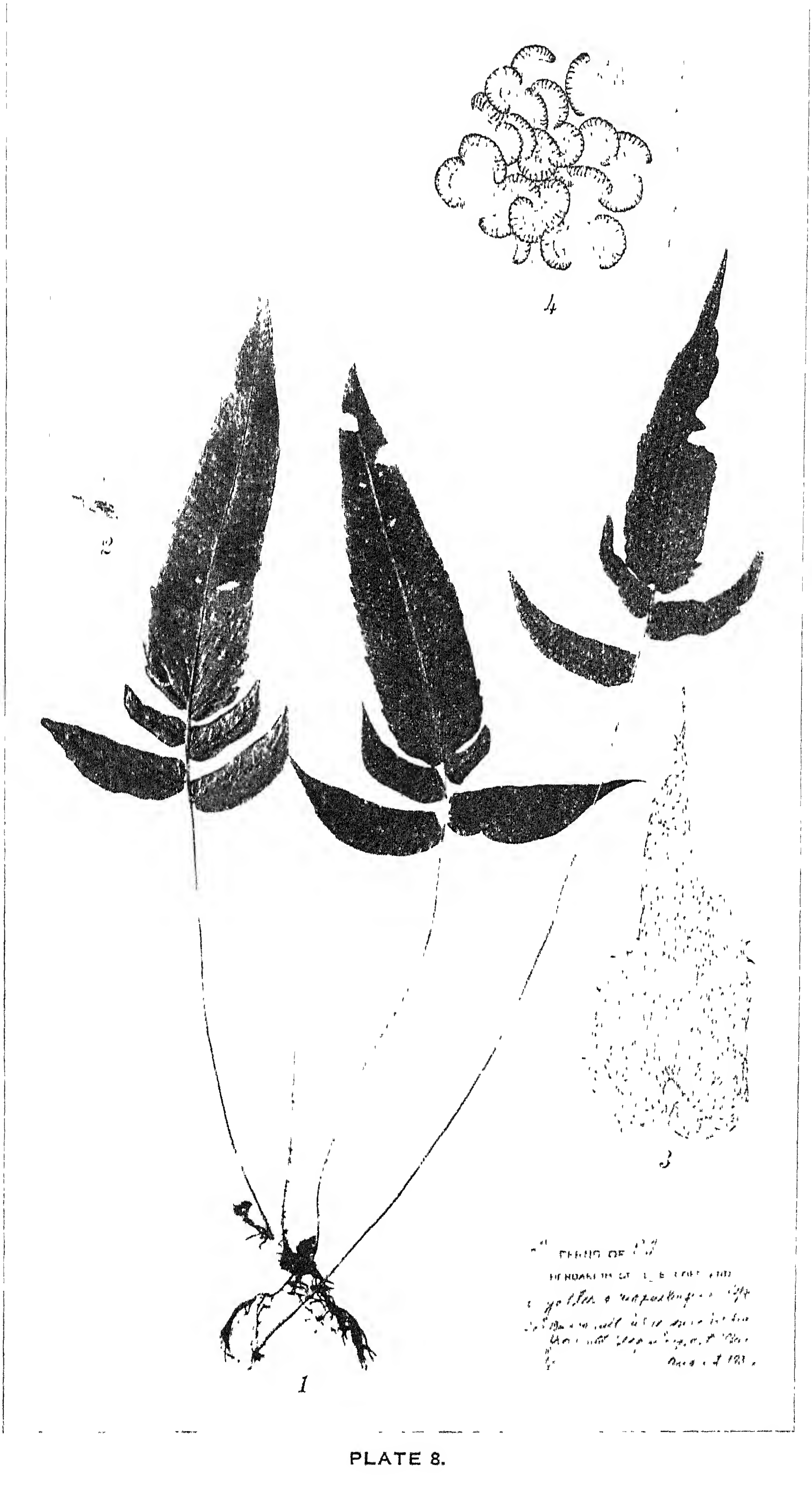

2
1
Ex Herbario Musei Britannici.
Nephrodium acrostichoides
Luzon
149 Cuming

PLATE 6.

PLATE 7.



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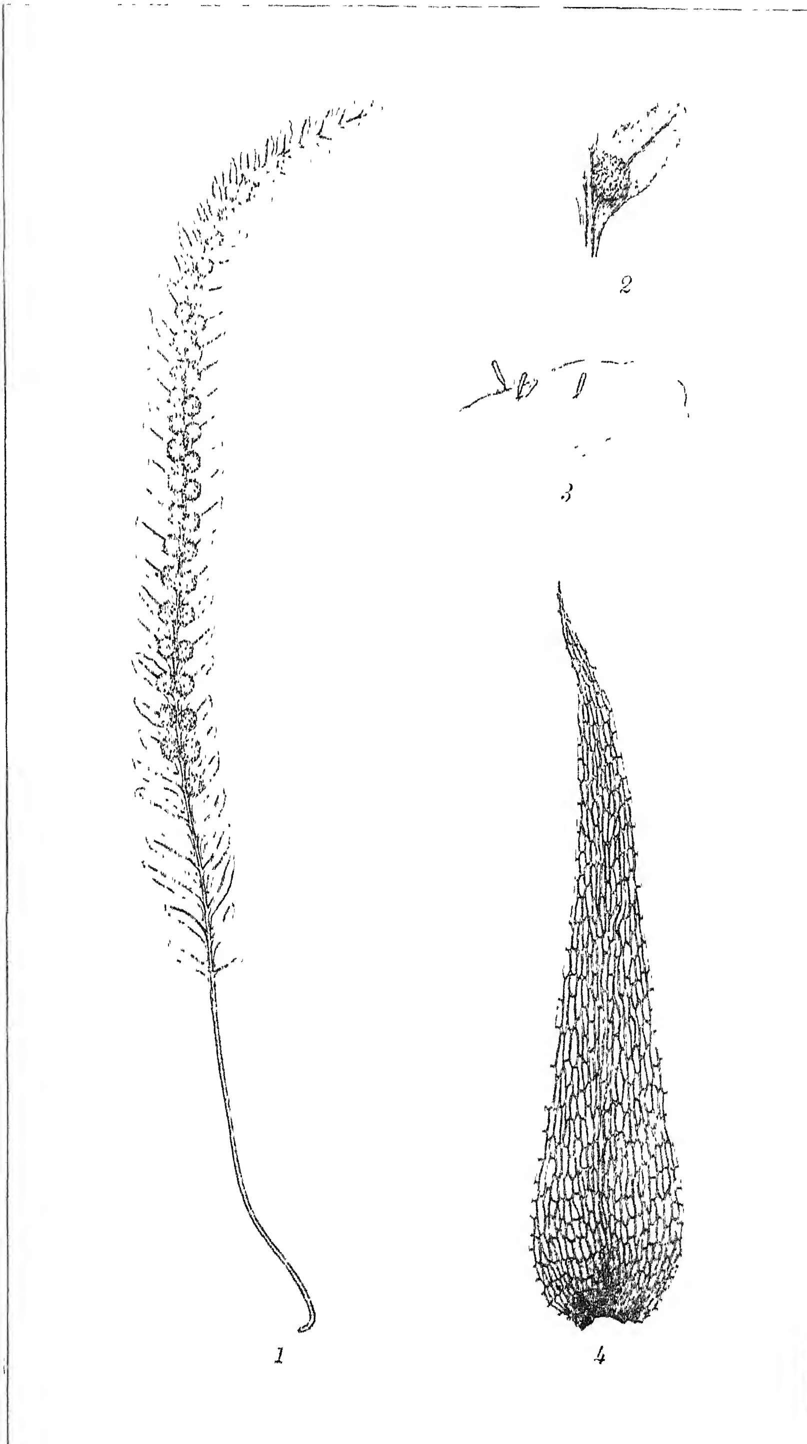

PLATE 9.

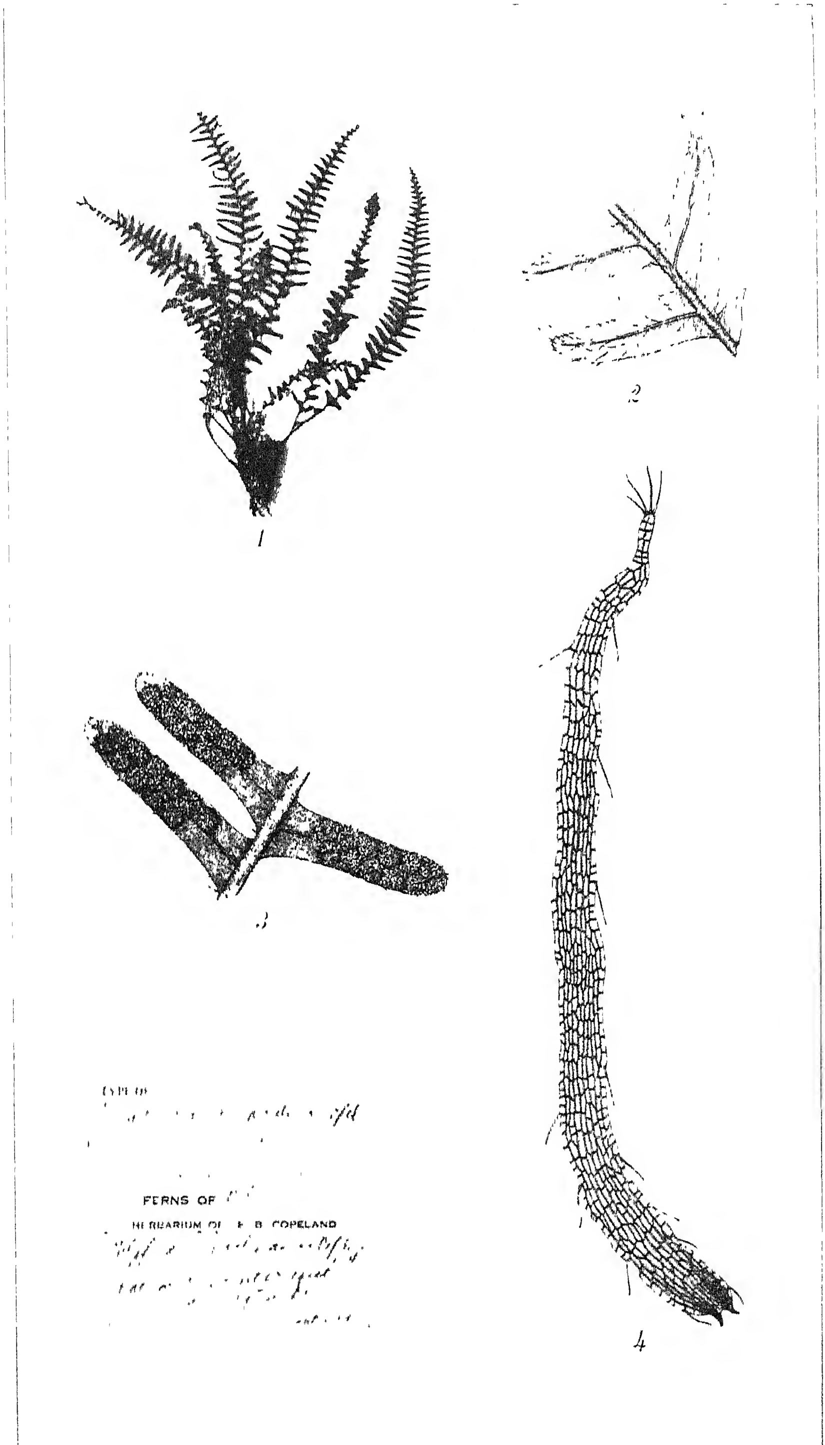

PLATE 10.

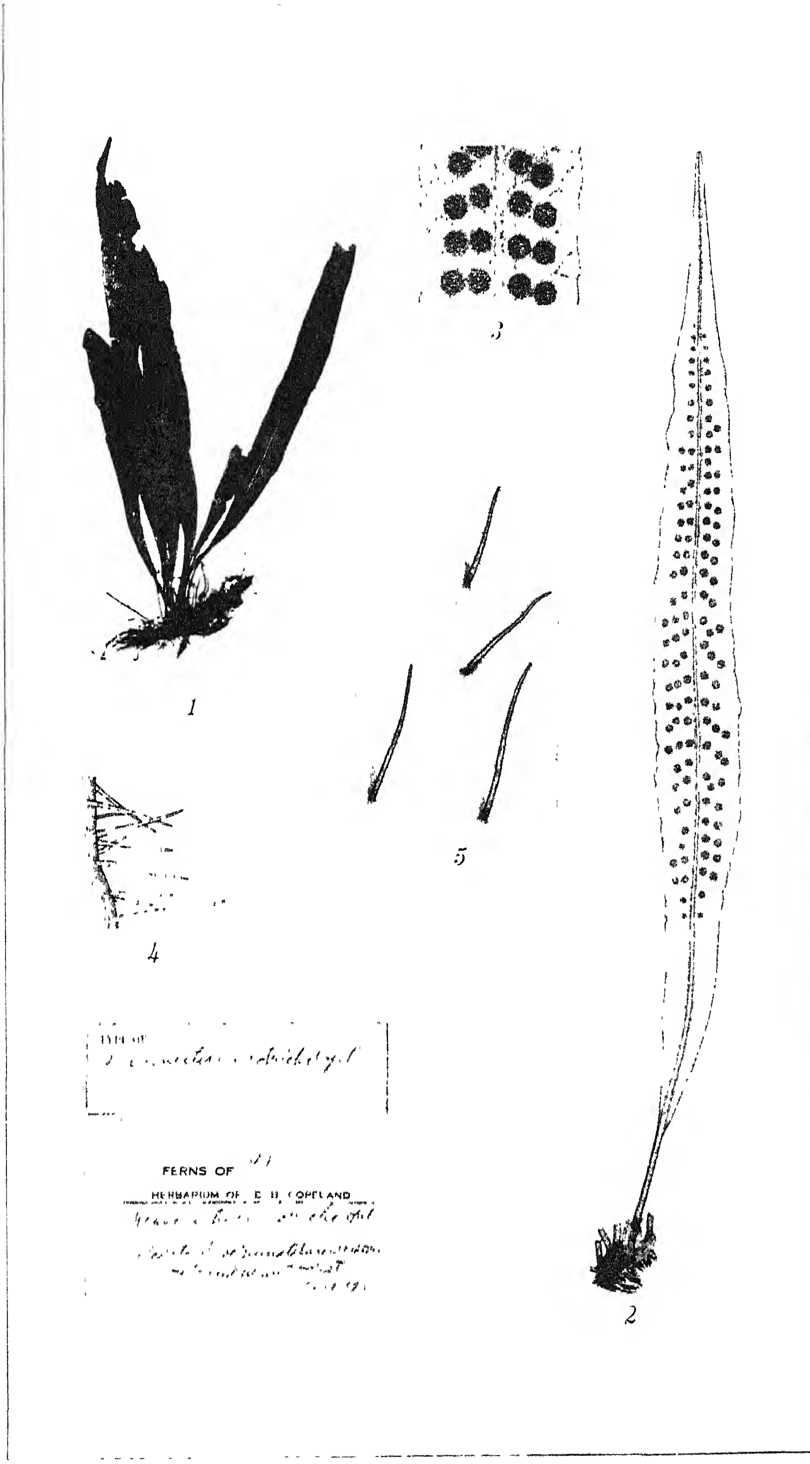

PLATE 11.

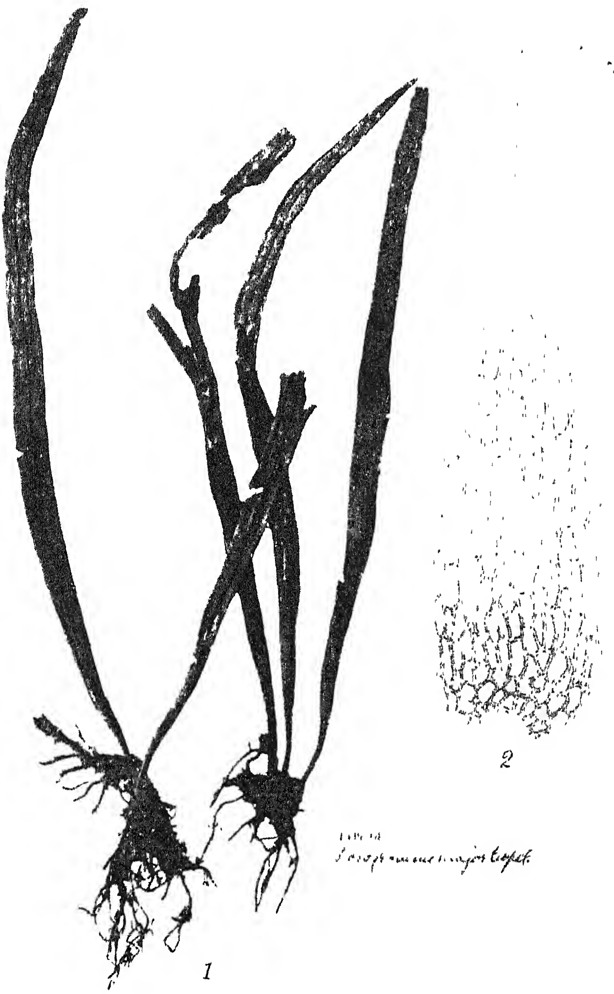

PLATE 12.

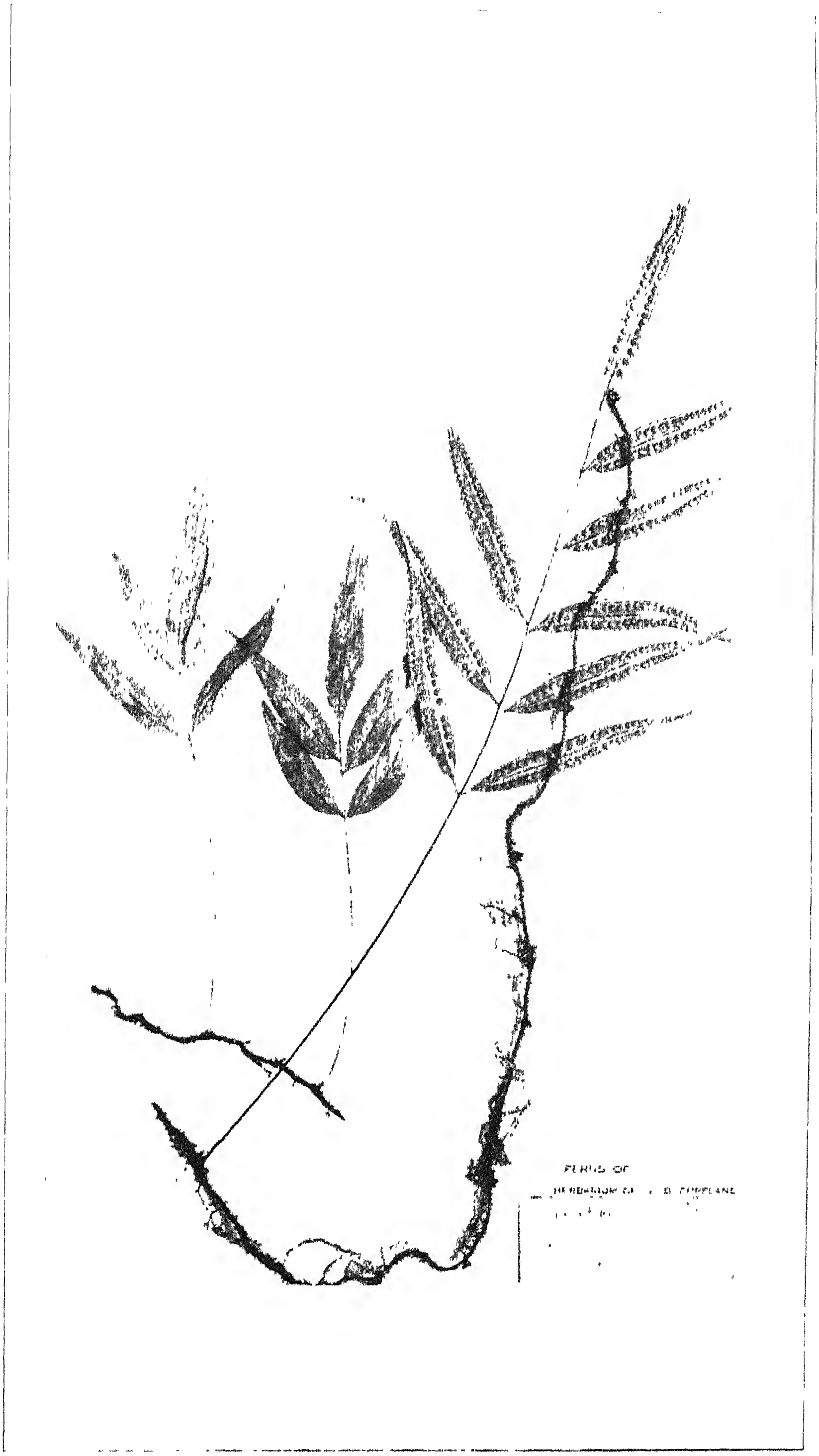

PLATE 13.

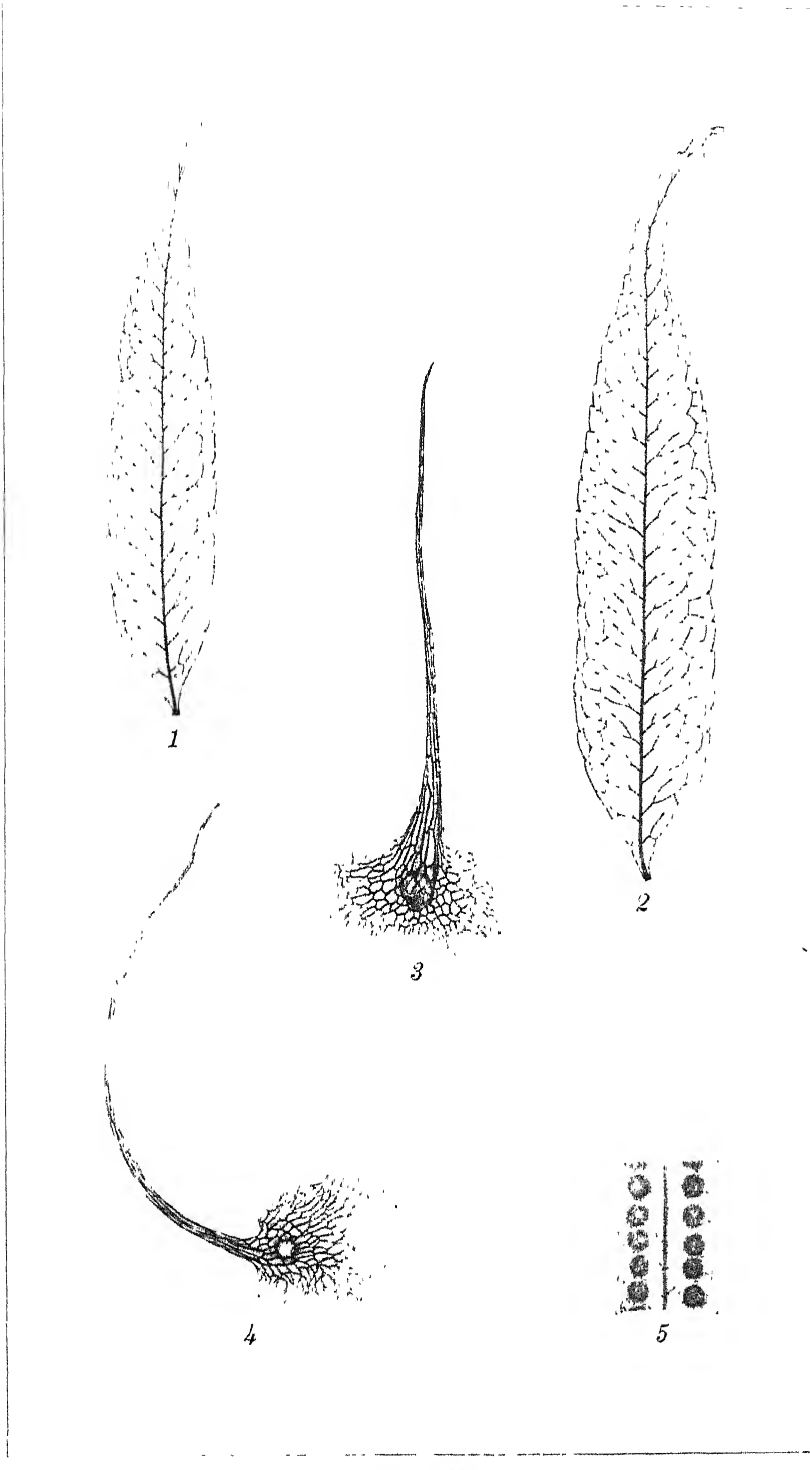

PLATE 14.

CONTROL OF PINEAPPLE MEALY-BUG WILT[1]

By F. B. SERRANO[2]

Of the Bureau of Science, Manila

TWO PLATES

INTRODUCTION

Pineapple mealy-bug wilt is by far the most destructive malady known to affect the pineapple plant, *Ananas comosus* (Linn.) Merr., particularly Smooth Cayenne, which is considered the premier commercial variety. It is characterized by a general wilting of the plant, with or without green spotting on the leaves. It assumes a number of forms depending upon the age, the succulence, and the vigor of the plant, as well as the size and time of onset of the initial mealy-bug infestation. A large population at the onset of the initial mealy-bug infestation produces quick wilt (Plate 1, fig. 4), while a small number of insects produces slow wilt (Plate 1, fig. 4, x). The younger and the more succulent and vigorous the plant is, the quicker it succumbs to quick wilt.

Pineapple mealy-bug wilt is caused by the toxic secretion of the pineapple mealy bug, *Pseudococcus brevipes* (Ckll.).(4) It is found everywhere the Smooth Cayenne pineapple is grown, causing almost complete collapse of the entire field, in several instances. While much has already been said by various investigators about its destructiveness, etc., no definite information about its control is given in any of the available literature on the subject. In view of this and of its economic importance, attempts were made immediately after its true cause was known to find ways and means to control it or at least to check its spread.

[1] This is a continuation of "Pineapple mealy-bug wilt in the Philippines," Philip. Journ. Sci. 55 (1934) 363–377.

[2] The writer wishes to express his thanks to the Philippine Packing Corporation for the splendid coöperation extended him in supplying practically all the material and labor used in conducting the experiments. He is also grateful to Dr. G. O. Ocfemia, of the Agricultural College, Laguna, for reading the manuscript.

HOW PINEAPPLE MEALY-BUG WILT SPREADS

Full knowledge of how the malady spreads is of prime importance in devising means of control. A more or less exhaustive investigation of the matter was therefore made, and it was ascertained that the pineapple mealy bug may be disseminated in three ways; namely, through infested plant material, through the agency of ants, and to some extent, through its own volition.

When plant material such as crowns or tops, slips, suckers, stumps, seedlings, and fruits are removed from an infested field without previous treatment for pineapple mealy-bug control, the pest may be introduced to new fields. This practice is in fact responsible for the rapid spread of the malady.

Another sure way of spreading the pest is through the aid of two species of ants, *Pheidole megacephala* (Fabr.) and *Solenopsis geminata* Fabr. var. *rufa* Jerdon, which feed on the honeydew secreted by the mealy bug and which, in return, take care of the young mealy bugs.

The pineapple mealy bug may also invade, although to a very limited extent, new pineapple plants through its own volition. It can crawl from leaf to leaf and from plant to plant. This is especially true with the gray strain or the green-spotting type(4) which does not seem to like remaining very long in one spot.

SPRAYING EXPERIMENTS

The spraying experiments for the control of the pineapple mealy bug were carried out in the pineapple fields of the Philippine Packing Corporation situated at Santa Fe, Bukidnon Province, Mindanao, from January to September, 1930. That year was climatically speaking unusually dry for that locality. It was, nevertheless, favorable for the mealy bugs and, fortunately, also for spraying.

EXPERIMENT 1

Materials and methods.—To find out the best insecticide for the control of the pineapple mealy bug the efficacy and feasibility of soapsuds spray, nicotine-soap spray, and oil-emulsion spray were tested. The experiment was laid out in January, 1930, on thirty-six double rows of standard length of 4-month-old Hawaiian Smooth Cayenne variety, spaced 56 by 22 by 18 inches. The plants were uniform in size and general vigor, with more or less uniform mealy-bug infestation, but showed no signs of wilt at the time.

The block was divided into three parts of twelve rows each. The first part was treated by spraying with 2 per cent soapsuds [3] rows 1 to 3 and 7 to 9 at monthly and bimonthly intervals, respectively, for four months, leaving rows 4 to 6 and 10 to 12 unsprayed as check. The second part instead was treated similarly with nicotine soap [4] for rows 13 to 15 and 19 to 21, and with oil emulsion [5] for rows 25 to 27 and 31 to 33, leaving the rest unsprayed as check. By means of a compressed-air spray pump (Plate 2) all of the plants except the check were sprayed one by one, each leaf thoroughly wetted, and the spray material driven between the closely appressed leaves and the heart especially, where an abundance of the mealy bugs is found.

Results.—At the close of the experiment observations on the general health and vigor of the plants were made. The results are presented in Table 1.

It is shown in Table 1, first, that the mealy-bug wilt of pineapple may be checked by spraying with either soapsuds, nicotine soap, or oil emulsion; second, that monthly application is more effective than bimonthly application; and third, that these sprays are practically the same in efficiency, soapsuds having 73.9 per cent; nicotine soap, 77.2 per cent; and oil emulsion, 83.3 per cent efficacy. The wilting of some of the sprayed plants may, perhaps, be explained by the fact that when the spraying was started several of the plants had already heavy mealy-bug infestation, although no signs of wilt were visible at the time. Had the spraying been started earlier or before the mealy bugs got well established, better results might have been obtained.

An after-effect of the treatment noticed is the scorching of the leaves sprayed with either nicotine soap or oil emulsion. Such harmful effect is, however, much more pronounced in the latter, in many instances causing decay of the heart or terminal

[3] Soap solution was prepared by dissolving 378.5 grams of laundry soap (Señorita) in water to make 19 liters of 2 per cent solution.

[4] Nicotine-soap was prepared by mixing 15 liters of 2 per cent soapsuds with 4 liters of concentrated tobacco decoction.

[5] Oil emulsion was prepared by emulsifying a mixture of 378.5 cc rope oil and 378.5 cc water, in which 378.5 grams brown pottery clay had been slaked. Emulsification is done by passing the mixture through a spray pump several times, then adding to it enough water to make 19 liters of 2 per cent emulsion. The mixture is repassed through the pump once more before using.

bud of the plant. Unfortunately the injury does not become manifest until after a month or so. The decay of the heart induces the plant to branch off in the form of five or more suckers, the production of which delays the maturing of the crop.

TABLE 1.—*Showing comparative efficacy of soapsuds, nicotine soap, and oil emulsion for the control of pineapple mealy-bug wilt.*

Rows.	Treatment.	Spraying intervals.	Observations.		Efficiency.
			Healthy.	Wilting.	
					Per cent.
1– 3	Soapsuds	Monthly	1,200	60	80.0
4– 6	Check		960	300	
7– 9	Soapsuds	Bimonthly	1,165	95	67.7
10–12	Check		966	294	
Average					73.9
13–15	Nicotine soap	Monthly	1,215	45	84.5
16–18	Check		969	291	
19–21	Nicotine soap	Bimonthly	1,167	93	69.9
22–24	Check		951	309	
Average					77.2
25–27	Oil emulsion	Monthly	1,221	39	87.0
28–30	Check		960	300	
31–33	Oil emulsion	Bimonthly	1,200	60	79.6
34–34	Check		966	294	
Average					83.3

EXPERIMENT 2

Owing to the cheapness, handiness, availability, and especially the efficacy of soapsuds spray, which proved to be practically as high as that of either nicotine soap or oil emulsion, it was decided to ascertain the best way to attain the most satisfactory results with it. Laboratory tests (the inclusion of which is deemed unnecessary) clearly showed that of the various brands of laundry soap, Señorita is the one that compares most favorably with Chinese Yellow in efficacy. Chinese White and Lenox are practically the same. Because Señorita soap has a more stable and more reliable consistency than Chinese Yellow, it was chosen for all subsequent experiments of this series as well as others in which soap is the main constituent of the spray solution.

Materials and methods.—This experiment was laid out in April, 1930, on fifty-four double rows (56 by 22 by 18 inches) of 4-month-old Hawaiian Smooth Cayenne plants in the pineapple fields of the Philippine Packing Corporation, at Santa Fe, Bukidnon, showing uniformity in general stand and vigor, as

well as in the distribution and extent of the pineapple mealy-bug infestation. Soapsuds in three dilutions, 1, 1.5, and 2 per cent, were employed in three different series; that is, as plain soapsuds, as soapsuds with brown pottery clay, and as hot soapsuds. Solutions of the various concentrations were prepared from a 10 per cent stock solution.

Starting with plain soapsuds, plants of rows 1 to 3 were sprayed thoroughly, one by one, with 1 per cent solution; rows 7 to 9, with 1.5 per cent; and rows 13 to 15, with 2 per cent, leaving rows 4 to 6, 10 to 12, and 16 to 18 unsprayed as check.

With the compressed-air pump spraying was done monthly for from two to five months, depending on the prevalence of the mealy bugs. The remaining rows were treated in like manner but with soapsuds containing 0.2 per cent brown pottery clay, for rows 19 to 21, 25 to 27, and 31 to 33, and plain soapsuds heated to from 45° to 50° C. for rows 37 to 39, 43 to 45, and 49 to 51, while the other rows, 22 to 24, 28 to 30, 34 to 36, 40 to 42, 46 to 48, and 52 to 54, remained unsprayed as check.

Results.—The observations made at the close of the experiment are presented in Table 2.

TABLE 2.—*Showing increase in the relative efficacy of soapsuds of different concentrations caused by the addition of clay and by heating.*

Rows.	Treatment.	Concentration.	Applications.	Observations.		Efficiency.
				Healthy.	Wilting.	
		Per cent.				*Per cent.*
1– 3	Soapsuds, plain	1.0	5	1,180	80	72.9
4– 6	Check			965	295	
7– 9	Soapsuds, plain	1.5	4	1,197	63	79.0
10–12	Check			959	301	
13–15	Soapsuds, plain	2.0	3	1,202	58	80.4
16–18	Check			963	297	
Average						77.5
19–21	Soapsuds plus 0.2 per cent clay	1.0	4	1,193	67	77.5
22–24	Check			962	298	
25–27	Soapsuds plus 0.2 per cent clay	1.5	3	1,200	60	80.0
28–30	Check			960	300	
31–33	Soapsuds plus 0.2 per cent clay	2.0	2	1,200	60	79.6
34–36	Check			966	294	
Average						79.0
37–39	Soapsuds, 45–50 °C	1.0	3	1,195	65	77.6
40–42	Check			970	290	
43–45	Sopasuds, 45–50 °C	1.5	2	1,200	60	79.9
46–48	Check			962	298	
49–51	Soapsuds, 45–50 °C	2.0	2	1,202	58	80.7
52–54	Check			960	300	
Average						79.4

Table 2 shows that the optimum concentration of soapsuds for the control of pineapple mealy-bug wilt seems to lie between 1.5 and 2 per cent, and that the addition of 0.2 per cent brown pottery clay or heating the solution to from 45° to 54° C. renders the soapsuds more effective. These facts are indicated by the number of applications needed by each treatment, by the number of healthy and diseased plants, and by the average percentage of efficiency. As in the first experiment it was also noted that the plants that came out diseased in the sprayed rows are those which have had more or less heavy mealy-bug infestation, although they showed no signs of wilt when the experiment was started.

In field practice one of the things tried to make the spray more effective and giving satisfactory results was to brush the mealy bugs off with a long-handled brush (Plate 2), simultaneously with spraying. High pressure was also found to contribute to the effectiveness of the spray. The higher the pressure at which the spray is delivered the quicker and the surer the mealy bugs are stripped of their woolly and waxy covering, hence the quicker they succumb to the treatment.

DIPPING EXPERIMENTS

While spraying is necessary for the control of pineapple mealy-bug wilt once the pest has gained foothold in the field, greater emphasis must be placed on using only mealy-bug-free plant material (suckers, slips, crowns, etc.), particularly in starting new plantations. This was clearly demonstrated by the check plants used in the infestation experiments.(4) Whenever possible plant material should be obtained only from mealy-bug-free fields. If the plantations are infested, however, efforts should be made to select the plant material from mealy-bug-free individuals. Otherwise effective treatment of some kind, like dipping, must be resorted to before setting out the plants.

As it has been shown conclusively in the writer's earlier article(4) that pineapple mealy-bug wilt is caused by the pineapple mealy bug, *Pseudococcus brevipes* (Ckll.), it is axiomatic that the exclusion of the insect will prevent the malady. It was felt to be of prime importance, therefore, to search for an effective means by which the plant material could be freed from the mealy bugs, granting that such plant material was infested. In the preceding spraying experiments it was revealed that soapsuds are just as good as, if not better than, either nico-

tine soap or oil emulsion for the control of the pineapple mealy bug, because of their handiness, cheapness, feasibility, stability, and high order of efficacy. The following experiments, started November 1, 1930, in Santa Fe, Bukidnon Province, were designed to explore the suitability of soapsuds as a dipping solution.

EXPERIMENT 3

Materials and methods.—Three different concentrations of soapsuds were prepared; namely, 44 liters of 1 per cent, 44 liters of 1.5 per cent, and 44 liters of 2 per cent; each solution was divided into four equal parts and kept in empty gasoline cans. Stumps of wilting 8-month-old Smooth Cayenne plants showing mealy bugs in abundance were collected and trimmed. Nine of such stumps were immersed in the first solution; three of them were "fished out" after 10 minutes, three after 20 minutes, and the remaining three after 30 minutes, and each batch was placed in a separate, properly labelled, enameled pan with the lips lined with Tanglefoot preparation to prevent ants from taking away any mealy bugs that might survive the treatment. The same number of stumps were treated similarly in the second solution, another batch in the third solution, and still another in the fourth, the latter two solutions being kept at a temperature ranging between 54° and 55° C. during the treatment. This completes the tests in the first series of 1 per cent solution. Tests on the remaining two series of 1.5 per cent and 2 per cent solutions were carried out in exactly the same manner and with the same number and kind of stumps infested with an abundance of pineapple mealy bugs. Care was taken to make the conditions of the experiment in all essentials as nearly identical as possible throughout the whole series.

Results.—The following day the stumps of the three series were examined minutely, one by one, with the help of a binocular for the mealy bugs present, dead or alive. The results are given in Table 3.

Table 3 shows that for the control of pineapple mealy-bug wilt soapsuds are more effective with pottery clay than without, and that their efficacy is increased by more than twice when the solution is heated to and maintained at a temperature of 54° to 55° C. during the treatment. It is also shown that at room temperature 1 per cent is as ineffective as either 1.5 per cent or 2 per cent; but when used at 54° to 55° C. they are equally

TABLE 3.—*The number of living and the number and percentage of dead mealy bugs found on each plant material after dipping in unheated and hot soap solution of different concentrations with and without the addition of pottery clay.*

Solution.	Concentration.	Temperature.	Duration of exposure in minutes.									Average efficacy.
			10			20			30			
			Alive.	Dead.	Efficacy.	Alive.	Dead.	Efficacy.	Alive.	Dead.	Efficacy.	
	Per cent.	°C.			*Per cent.*			*Per cent.*				*Per cent.*
Soapsuds, plain	1.0	26–27	545	165	23.2	801	384	32.4	490	370	43.0	32.8
Soapsuds plus 0.2 per cent clay	1.0	26–27	490	268	35.3	472	326	40.8	288	376	56.6	44.2
Soapsuds, plain	1.0	54–55	6	534	88.8	0	540	100.0	0	330	100.0	96.3
Soapsuds plus 0.2 per cent clay	1.0	54–55	0	652	100.0	0	04	100.0	0	589	100.0	100.0
Soapsuds, plain	1.5	26–27	574	222	37.9	491	391	44.3	285	312	52.2	41.4
Soapsuds plus 0.2 per cent clay	1.5	26–27	440	274	38.3	356	364	50.5	240	420	63.6	50.8
Soapsuds, plain	1.5	54–55	10	579	98.3	0	490	100.0	0	712	100.0	99.4
Soapsuds plus 0.2 per cent clay	1.5	54–55	0	712	100.0	0	489	100.0	0	605	100.0	100.0
Soapsuds, plain	2.0	26–27	405	262	37.7	584	418	41.7	286	384	57.3	45.6
Soapsuds plus 0.2 per cent clay	2.0	26–27	496	336	40.3	432	382	46.9	204	432	67.9	51.7
Soapsuds, plain	2.0	54–55	5	657	99.2	0	620	100.0	0	718	100.0	99.7
Soapsuds plus 0.2 per cent clay	2.0	54–55	0	543	100.0	0	477	100.0	0	490	100.0	100.0

effective, rendering mealy-bug-infested stumps absolutely free from the infestation in ten minutes if 0.2 per cent pottery clay is added to the solution, and in twenty minutes if no pottery clay is added.

Another point brought out by these results is that in spraying 1.5 per cent soapsuds gives 100 per cent killing power or efficiency, whereas preparations at even higher concentrations are practically useless as dipping solutions unless applied hot. In order, therefore, that a spraying solution of given concentration may be effective as a dipping solution it must be used hot. It is pertinent, perhaps, to mention in this connection that heat alone at a temperature of 54° to 55° C. does not kill the mealy bugs; when infested plant specimens were immersed in tap water at the same temperature for the same duration, none of the mealy bugs was killed.

EXPERIMENT 4

It has been amply demonstrated in the preceding experiments that soapsuds of any reasonable concentration are not sufficiently effective as a dipping solution for the control of the pineapple mealy bug unless used hot. It was desirable, therefore, to find out the best temperature and time exposure for each type of pineapple plant material.

Materials and methods.—Ninety liters of 1.5 per cent soapsuds were prepared and divided equally in six empty gasoline cans numbered from 1 to 6. Solution 1 was heated, and upon reaching the temperature of 39° to 40° C., at which it was maintained, nine trimmed stumps of 8-month-old wilting Smooth Cayenne plants were immersed in it; three of them were "fished out" after 40 minutes, three after 50 minutes, and the last three after 60 minutes, and each set was placed separately in an enameled basin with lips lined with Tanglefoot preparation to prevent ants from taking away any mealy bug that might survive the treatment. After this, three batches consisting of nine suckers weighing about 150 grams each, nine slips of about 100 grams each, and nine crowns of about 50 grams each were treated similarly, one by one, while the temperature of the soap solution was maintained at 30° to 40° C. The same kinds and number of plant materials were treated, in an identical manner, but with one series at 42° to 43° C., one at 45° to 46° C., one at 48° to 49° C., one at 51° to 52° C., and another at 54° to 55° C.

TABLE 4.—*The number of living and the number and percentage of dead mealy bugs found on each plant material and the degree of scorching of each kind of plant material after immersion in 1.5 per cent soap solution at different temperatures and exposures.*

Group.	Temperature of solution.	Exposure.	Observations.					
			Stumps.			Suckers, ± 150 grams each.	Slips, ± 100 grams each.	Crowns, ± 50 grams each.
			Alive	Dead.	Efficacy.			
	°C.	Min.			Per cent.			
1	39–40	40	18	1,720	97.8	Normal	Normal	Normal.
	39–40	50	16	1,940	99.2	do	do	Do.
	39–40	60	0	1,595	100.0	do	do	Do.
2	42–43	40	9	1,416	99.3	do	do	Do.
	42–43	45	6	1,992	99.7	do	do	Do.
	42–43	50	0	1,566	100.0	do	do	Do.
3	45–46	30	14	1,445	99.0	do	do	Slightly scorched.
	45–46	35	0	1,427	100.0	do	do	Do.
	45–46	40	0	1,507	100.0	do	do	Do.
4	48–49	15	16	1,501	98.8	do	Severely scorched.	Severely scorched
	48–49	20	0	1,776	100.0	do	do	Do.
	48–49	25	0	1,522	100.0	do	do	Do.
5	51–52	10	17	1,129	98.5	Severely scorched.	do	Do.
	51–52	15	0	1,577	100.0	do	do	Do.
	51–52	20	0	1,757	100.0	do	do	Do.
6	54–55	5	13	1,220	98.9	do	do	Do.
	54–55	10	0	1,566	100.0	do	do	Do.
	54–55	15	0	1,518	100.0	do	do	Do.

Results.—The following day all of the stumps were minutely examined, one by one, under a binocular, and the mortality of the mealy bugs present on each noted. This having been completed, all of the shoots and crowns were gone over, group by group, the next day, for any sign of scorching that the treatment might have produced thereon, and classified as normal, slightly scorched, or severely scorched, as the case might be. The results are given in Table 4.

It is shown in Table 4 that a 100 per cent killing of the pineapple mealy bugs can be effected by soaking the plant material 60 minutes in soapsuds of 1.5 per cent concentration with 0.2 per cent brown pottery clay at a temperature of 39° to 40° C.; 50 minutes at 42° to 43° C.; 35 minutes at 45° to 46° C.; 20 minutes at 48° to 49° C.; 15 minutes at 51° to 52°

C., and 10 minutes at 54° to 55° C. It is also shown that suckers weighing about 150 grams each can withstand soaking for 20 minutes at 48° to 49° C. without danger of becoming scorched; slips weighing about 100 grams each, for 35 minutes at 45° to 46° C.; and crowns weighing about 50 grams each, for 50 minutes at 42° to 43° C. It is quite evident from these results that pineapple plant material of all types may be freed from mealy-bug infestation by soaking in hot 1.5 per cent soap solution, in the following order:

Stumps, 15 minutes at 51° to 52° C.
Suckers, 150 grams, 20 minutes at 48° to 49° C.
Slips, 100 grams, 35 minutes at 45° to 46° C.
Crowns, 50 grams, 50 minutes at 42° to 43° C.
Seedlings, small, 60 minutes at 39° to 40° C.

The results of both spraying and dipping experiments as presented in the preceding tabulations become more significant in the light of Carter's(1) revelation of the results of his laboratory and field tests in dipping and spraying for mealy-bug control in Hawaii, stating among other things, that various commercial oil emulsions provide a satisfactory means of control, although the susceptibility of the plants to scorching imposes severe restrictions on their use. The writer found this to be so when comparison between the efficiency of soapsuds, nicotine soap, and oil emulsion for the same purpose was made.

VACUUM FUMIGATION

Another possibility to render the plant material free from the mealy bugs is vacuum fumigation. That this possibility merits consideration is shown by the report of Hagan(3) in Hawaii, that vacuum fumigation with hydrocyanic acid gas at the rate of 10 ounces sodium cyanide to 1,000 cubic feet of space for one to one and one-half hours and 28 inches of vacuum at the start, gave satisfactory results. Similar treatment with either carbon bisulphide or chlorpicrin resulted, however, in great injury to the plant material.

SCOUTING

Scouting to locate the focus of infestation is of fundamental importance and should go hand-in-hand with spraying. In fact it should precede spraying. This is especially necessary when plants are still young and the mealy bugs not yet well established. Its usefulness cannot be overemphasized considering the

fact that the malady does not become conspicuous until after the infestation has gone too far to respond to drastic and costly treatment. An early discovery of its occurrence is of fundamental value. This can be effected by proper scouting under trained personnel at least once a month.

NATURAL ENEMIES AND PREDATORS

The pineapple mealy bug has a number of natural enemies and predators, such as the brown lacewing sympherobid, *Sympherobius augustus;* the ladybird beetle, *Cryptolaemus montrouzieri* Muls.; *Lobodiplosis pseudococci* Felt;(2) and a grasshopper, *Conocephalus saltator* Sauss. The first two were introduced from Hawaii by the Philippine Packing Corporation, in 1930, in Bukidnon Province, Mindanao. Efforts should be made to encourage the rapid multiplication and spread of such benefactors, for under ordinary conditions they should be able to hold the mealy bugs under control.

ANT CONTROL

While there are natural enemies and predators attacking the pineapple mealy bug, there are also on the other hand insects protecting it. Two species of ants, *Pheidole megacephala* (Fabr.) and *Solenopsis geminata* Fabr. var. *rufa* Jerdon are known to do this. They feed on the honeydew secreted by the mealy bug whose young they protect in return from enemies. Keeping these ants under check will therefore not only enhance the activities of the natural enemies and predators of the pineapple mealy bug but will also adversely affect the general vigor and fecundity of the mealy bug itself.

Controlling these ants, particularly the red variety, *Solenopsis geminata* Fabr. var. *rufa* Jerdon, is not an easy matter. However, clean culture and surface mulching by harrowing the ground of the plantation, whenever possible, may help in driving them away. Simple soapsuds spray as employed for the mealy bug treatment is effective and cheap enough to use for the black ant, *Pheidole megacephala* (Fabr.), which may be killed in its dugouts by pouring the solution into the holes. The red ant, on the other hand, never appears greatly concerned when treated with any of the three insecticides which proved destructive to the mealy bug. Fumigants like chlorpicrin, carbon bisulphide, and hydrocyanic acid gas may prove effective in the control of both ants, and their applicability should be carefully and thoroughly studied.

BORDER PLANTING

On the assumption that new fields planted to mealy-bug-free seeds are adjacent to infested old fields, border planting as supplementary means of checking the malady seems advisable. This would tend to slow down the influx of the mealy bugs migrating from a mealy-bug-laden field, and to localize infestation, thereby facilitating spraying operations. Border planting to be effective must consist of a bed of at least four rows and the plants must be as succulent and vigorous as those in the main plantation so as to provide enough inducement for the mealy bug to remain. These conditions are necessary for detaining the insect in the border planting and effectively checking its advance.

SUMMARY

1. It has been observed that the pineapple mealy-bug wilt may be disseminated in a number of ways; namely, through infested plant material, such as suckers, slips, crowns, etc., through ants, and through the mealy bug's own volition.

2. Field tests have shown that the pineapple mealy-bug wilt may be controlled by spraying about once a month with 1.5 per cent soap solution. The addition of pottery clay (about 0.2 per cent), preferably the brown type, renders the solution more effective.

3. Nicotine-soap solution and oil emulsion have proved to be practically as effective as soapsuds, if not more so, in killing the pineapple mealy bug. Owing, however, to their scorching effect on plants, which is quite serious, particularly in the case of oil emulsions, their application is considered rather precarious. Hence, soap solution is considered preferable.

4. Laboratory tests have shown that of the different brands of laundry soap tried the Chinese Yellow has the highest efficiency, followed closely by the Señorita. The Chinese White and the Lenox are practically of the same strength.

5. For dipping purposes soapsuds at any reasonable concentration are practically worthless unless used hot, as follows: Stumps, 15 minutes at 51° to 52° C.; suckers, about 150 grams, 20 minutes at 48° to 49° C.; slips, about 100 grams, 35 minutes at 45° to 46° C.; crowns, about 50 grams, 50 minutes at 42° to 43° C.; seedlings, 60 minutes at 39° to 40° C. Complete freedom from the pineapple mealy bug is secured by dipping infested plant material in 1.5 per cent soap solution at these temperatures and corresponding time exposures. One-hundred-ninety-liter

barrels or large vats equipped with heaters may be used for this purpose.

6. As in spraying, the addition of pottery clay (about 0.2 per cent), preferably the brown type, renders the dipping solution more effective, while heating to 45° to 50° C. increases its efficacy more than twice.

7. Proper scouting to locate the focus of infestation is necessary for successful spraying. It is especially needed in young plantations where the mealy-bug colonies may actually become established rapidly although no outward manifestations of the malady are yet shown.

8. Quick reproduction and spread of the pineapple mealy-bug's natural enemies and predators—such as, *Sympherobius augustus*, *Cryptolaemus montrouzieri* Muls., *Lobodiplosis pseudococci* Felt, and *Conocephalus saltator* Sauss.—should be studied and the results obtained therefrom disseminated among pineapple growers.

9. Keeping under check the ants *Pheidole megacephala* (Fabr.) and *Solenopsis geminata* Fabr. var. *rufa* Jerdon, which are in symbiotic association with the pineapple mealy bug, *Pseudococcus brevipes* (Ckll.), will materially help in keeping the malady under control.

10. In starting new plantations in districts where the malady is more or less well established border planting is a necessary precaution, particularly when ants are abundant.

11. The need for using nothing but mealy-bug-free plant material in opening new plantations cannot be overemphasized. This may be accomplished by either selecting plant material from mealy-bug-free fields or properly treating the mealy-bug-infested plant material prior to planting.

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ILLUSTRATIONS

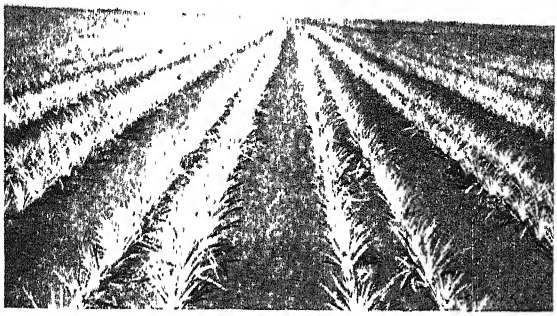
Plate 1

Fig. 1. Three-month-old Smooth Cayenne plantation free from wilt. Planting material was treated with dipping soap solution before planting.

2. Same as fig. 1, eighth month; the plant is still free from wilt.
3. Same as figs. 1 and 2, thirteenth month; the plant is still free from wilt.
4. Thirteen-month-old Smooth Cayenne plantation on the verge of collapse due to wilt. Plant material was not treated for mealybug control before planting. Plants in the foreground are victims of quick wilt, while those marked x are suffering from slow wilt. All figures about $\times$ 0.02. (All photographs by the author.)

Plate 2

Compressed-air spray pump, with a handmade long-handled brush on the left side; about $\times$ 0.2. (Photograph by C. S. Angbengco.)



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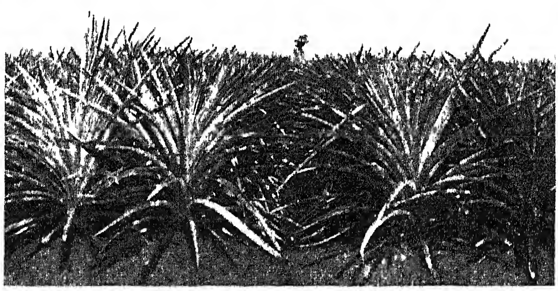

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PLATE 1.

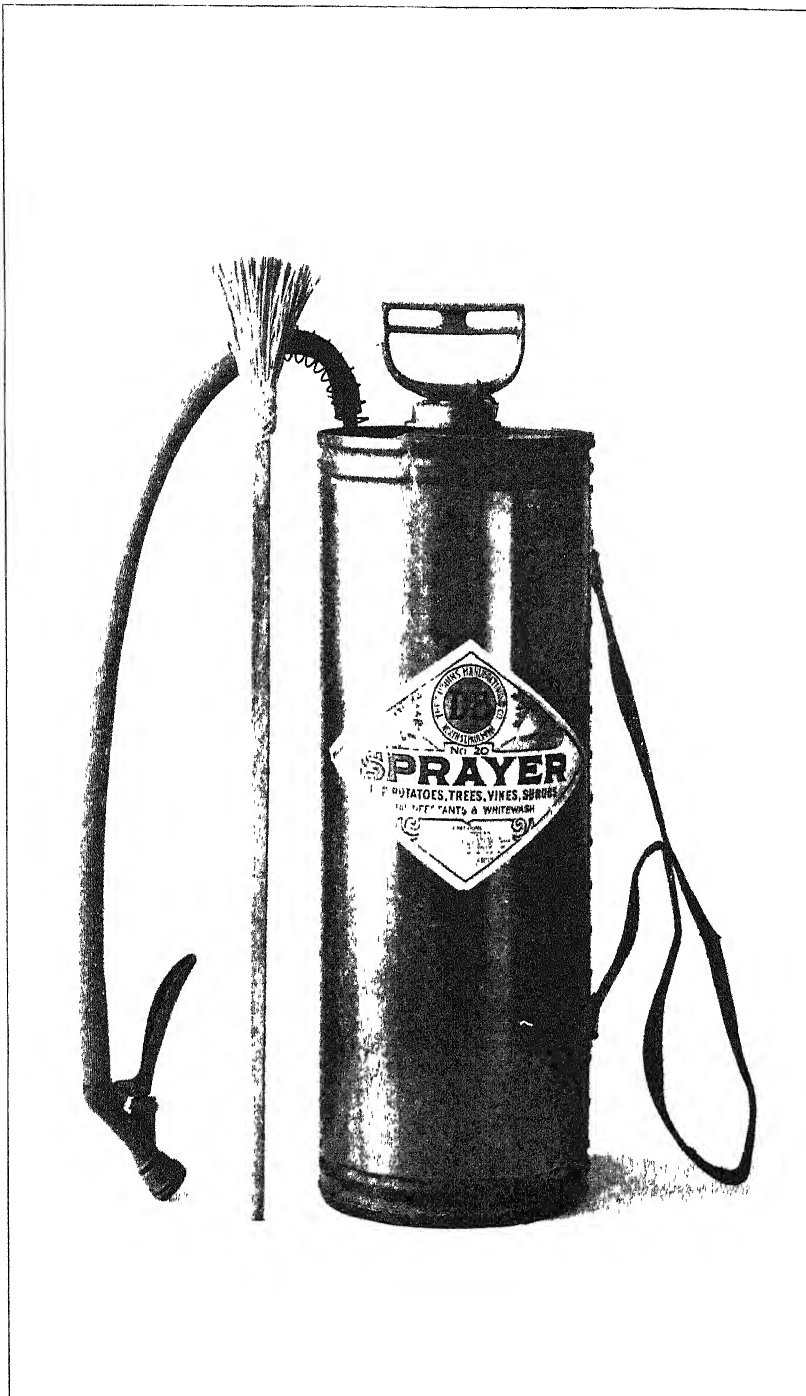

PLATE 2.

A MORPHOLOGICAL STUDY OF A NYMPHOMYIID FLY [1]

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FIVE PLATES AND SIX TEXT FIGURES

INTRODUCTION

The remarkable dipterous insect *Nymphomyia alba* Tokunaga, the subject of this investigation, was first collected in March, 1932, by myself along a torrential stream at Kibune, Kyoto (200 to 420 meters in altitude), a locality famous for its rich insect fauna and also known as the habitat of other peculiar insects; such as, *Epiophlebia suprestes* Salys (Odonata), *Deuterophlebia* sp. (Diptera), *Galloisiana nipponensis* Caudell and King (Orthoptera), *Lyeænopsis sugitanii* Matsumura (Lepidoptera), etc. In December, 1932, a brief report on this new species, from the taxonomic viewpoint, was published in Annotationes Zoologicæ Japonenses, the substance of this paper having been previously presented at the Eighth Annual Meeting of the Japanese Zoological Society held in October, 1932, at Taihoku, Formosa.

The present paper deals with the external morphology of this interesting form and gives, in addition to full descriptions of the structures, discussions on the homology of the sclerotization, concluding with a suggestion on the phylogenetic position of this fly among the dipterous insects.

Most of the nymphomyiid flies examined were collected in the fall of 1932 at Kibune, and preserved in 70 per cent alcohol after fixing in Carnoy's fluid. Living and dried material, and also that directly preserved in 70 per cent alcohol, as well as fixed material, was freely used in this study. For supplementary purposes various dipterous and other insects in the university collection were also examined. Dissections were carried out under a binocular microscope by means of steel and glass needles. When the material needed softening, it was treated in 5 per cent potassium hydroxide. Ziehl's carbolic fuchsin or

[1] Contribution from the entomological laboratory, Kyoto Imperial University, Japan, No. 36.

Mann's methyl-blue-eosin was used for the staining of the dissected pieces. Fine dissected pieces were observed under high magnification after mounting in glycerine-alcohol or cedar oil.

This investigation was undertaken under the direction of Prof. Dr. Hachiro Yuasa. For his invaluable assistance, which made this study possible, I desire to express my hearty thanks.

MORPHOLOGICAL DESCRIPTION

The morphological terminology used in this paper is mainly adopted from that of MacGillivray (1923) and of Tokunaga (1930 and 1932), supplemented from that of various modern writers.

In its general features this fly resembles a certain caddice-fly larva rather than any known dipterous insect. It is small and delicate, measuring about 2.3 millimeters in length, and is white in life. The important characteristic structures of this fly may be briefly described as follows:

1. The head is prognathous in type, with a very large occipital foramen, and elongated cephalad, forming a snoutlike projection. The mouth opening is located in the characteristic pocketlike mouth cavity and all of the mouth parts are almost completely atrophied. The compound eyes are contiguous on the ventral side. The two ocelli are located on the lateral sides of the head capsule and are very large. The antennæ are of brachycerous type characterized by the presence of the intersegmental sensillæ.

2. The thorax is elongated and cylindrical. The pronotum is completely subdivided into two, paired, lateral halves on the middorsal line, and the prosternum is represented by a very large, undivided, primary sternum to which a pair of the laterosternites has probably united. The mesopostscutellum is extremely developed. The mesopleura are small and membranous, and the mesosternum is very large, being divided into the presternum and the basisterno-sternellum. The metanotum is atrophied, while the metasternum is very large and represented only by the basisterno-sternellum, the presternum being lost. Generally the development of the endoskeletons is very poor.

3. The wings are very narrow, cuneiform, with very long marginal setæ and a well-developed ambient vein. The veins are very few and obscure. The squama and the alula are also greatly reduced. The halteres are normal in structure, but their basal sclerites are extremely reduced.

4. The three pairs of legs are separated widely from each other, and the forelegs are articulated on the lateral side. The trochantin is atrophied. All the legs are provided with elongated coxæ and trochanters, and each coxa is provided with a basicostal suture. Femora and tibiæ are subdivided into the proximal and distal regions by membranous rings. The claws and their accessory structures are simple. The empodium is slender and elongated. The calcanea is slender and squamous. The planta auxiliæ and pulvilli are wanting.

5. The differentiation of the pregenital segments is very slight in both sexes. The eighth abdominal segment in each sex is provided with special paratergal projections. The genital structures are exposed, and in neither sex of the concealed or telescopic type. The cerci of each sex are large and prominent. The postgenital segments are greatly reduced and uniformly fused with each other. The abdominal spiracles are all wanting.

THE HEAD

The head capsule of this fly (text fig. 1 and Plate 1, figs. 1 to 4) is quite unique both in shape and structure. The head is small, conical, elongated cephalad forming a snoutlike projection, and cephaloventrad, a labiumlike projection. The sclerites of the head capsule are fused with each other, forming a common capsule, which is entirely covered with a fine pubescence and somewhat setigerous with slender setæ. The sutures of the head are almost atrophied except for a shallow and incomplete suture on the caudodorsal region. This is a part of the epicranial stem (*es*). The occipital foramen (*of*) is very large, slightly smaller than the width of the head, round, without distinct odontoideæ but uniformly thickened along the margin. The endoskeletons (tentorium) of the head (supratentoria, pretentoria, and metatentoria) and tentorinæ (supratentorinæ, pretentorinæ, and metatentorinæ) are all wanting. Thus, in this species the muscles of the head are directly attached to the cuticular dermis without the intermediation of the chitinized tendons.

The compound eyes (*ce*) are subequal in size and shape in both sexes, oval in shape in the lateral aspect, without velutinous hairs on the surface, contiguous on the ventral side but widely separated on the dorsal. The distance between them is two-thirds the vertical length of an eye. The facets of the eyes are biconvex and granulose in appearance; there are about forty on each eye. The oculata (*ol*) is large, thickened, dark,

somewhat broader on the ventral side, and with a fine pubescence on its ectomarginal surface. On the midventral side the basal parts of the paired oculatæ are completely fused with each other, but their distal marginal parts are widely separated, so as to appear T-shaped in cross section at this point. The ocelli (*oc*) are very large, paired, present laterally or caudad of the compound eyes, or on the widest region of the head capsule; each ocellus consists of a common hyaline exocuticula and a biconvex, glassily hyaline, independent cuticular lens under which a variable amount of pigmental material is arranged in masses. The dorsomedian ocellus is wanting.

The antennæ are short, 5-segmented, and brachycerous in type in both sexes, located very near to each other on the dorsal side of the base of the snoutlike projection (*sn*) or cephalad of the compound eyes, but independently inserted in the small antacoriæ under a small common visorlike projection. This blunt structure (*vr*) is a mere projection of the head capsule and has no homologous relation with the ptilinum of the higher Diptera. The antennaria is completely fused with the common head capsule and not visible as an independent sclerite. The basal segment, scape (*sp*), is pyriform and entirely covered with a fine pubescence, with several (usually five) small, soft, slender setæ on the distal margin. The proximal part of this segment is narrow, and this margin is thickly chitinized but without distinct antartis. The second segment, or pedicel (*p*), is somewhat smaller than the scape, and spherical; it is also covered with a fine pubescence on the entire surface and with minute hyaline sensillæ on the distal half but without setæ, and articulated to the scape by a broad coria. The third segment (fl_1), proximal segment of the flagellum, is rather more membranous than the other segments; it is very large, about 1.5 times as long as the preceding two segments taken together, somewhat spoon-shaped and flattened, entirely covered with a very minute pubescence, with minute sensillæ, but without verticils, ordinary setæ. The remaining two segments of the flagellum are very minute and completely bare, not membranous, but thickened and slightly brown under transmitted light. The proximal of these two segments (fl_2) is cylindrical, subequal in length to its width, while the terminal one (fl_3) is elongated, conical, somewhat needlelike, and three or four times as long as the penultimate segment. Between the distal two segments of the flagellum are three clavate, hyaline, interseg-

mental sensillæ (*is*). These are very difficult to detect as they are quite hyaline.

The mouth cavity (*mc*) opens very near the ventral labium-like projection at the innermost part of the thickened cuplike concavity that is located on the proximoventral side of the snoutlike projection of the head capsule. The mouth parts are represented only by a small papilliform membranous projection (*la*), which shows a double nature, having two papillæ, and located at the entrance of the mouth cavity or on the caudal side of the pocketlike concavity. This membranous projection of the mouth parts may be taken as a reduced labial appendage like the labellum (paraglossa), judged by its location, but its exact morphological homology is not known. The other mouth parts—such as, the labrum, mandible, maxilla, maxillary palpus, hypopharynx, etc.—are completely atropied.

The basipharynx and postpharynx are well retained in spite of the extreme reduction of the prepharynx and hypopharynx and the complete atrophy of the external trophic organs. The basipharynx (text fig. 1, *bx*) is a short canal extended obliquely, consisting of a thick dorsal wall and a thin ventral membrane, and invested with thin common ring muscles. In cross section the shape of the basipharynx is somewhat crescentic, the dorsal wall being convex ventrad and the ventral wall concave dorsad in the state of relaxation of the dilators, as usual with Diptera. The anterior end of the basipharynx is thinly membranous and directly continuous with the mouth concavity completely losing the hypopharynx and propharynx, whereas the posterior end is thickly chitinized and provided with a thicker muscular investment. The cornu, or tuberculous projection of the caudal end of the basipharynx, is not developed as highly as in the Diptera in general.

The œsophageal pump (text fig. 1, *op*) is slender, supported horizontally, as the head is prognathous in type, at the center of the head capsule, passing between the supra- and subœsophageal ganglia. The cephalic region of the œsophageal pump is comparatively large and gradually narrowed caudad. The cephalic end of the pump is expanded cephalad beyond the junction with the basipharynx, forming a saclike structure below the frontal ganglion. In the cross section (text fig. 1, *a* to *c*) the dorsal wall of the pump is thickly chitinized, while the ventral wall is almost as thick as the dorsal but not chitinized and easily flexible. The lateral wall is very delicate, membranous, and in the state

of relaxation of the dilators or of contraction of the ring muscles the œsophageal pump is folded vertically at this lateral side as shown in the series of sections *a* to *c*. Although the œsophageal pump is more or less developed throughout the Orthorrhapha Diptera, as pointed out by Peterson (1916), in the present fly it is somewhat different in structure from the pump in the other nematocerous flies. Generally in the Nematocera the cross

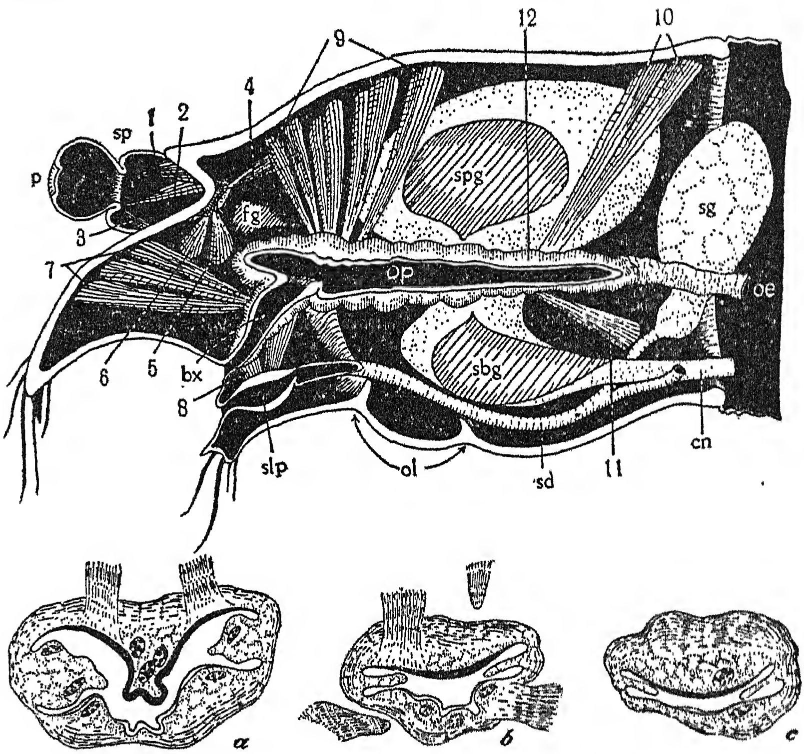

FIG. 1. Head of *Nymphomyia alba* Tokunaga. Cross sections of the basipharynx; *a*, through the attachments of the anterior dilators; *b*, through those of the posterior dilators and, *c*, of the posterior region before the œsophagus. *bx*, Basipharynx; *cn*, connective nerve; *fg*, frontal ganglion; *oe*, œsophagus; *ol*, oculata; *op*, œsophageal pump; *p*, pedicel; *sbg*, subœsophageal ganglion; *sd*, salivary duct; *sg*, salivary gland; *slp*, salivary pump; *sp*, scape; *spg*, supraœsophageal ganglion.

section of the pump is somewhat triangular and in a contracted state (relaxation of the dilators) is Y-shaped. Thus, in the Nematocera the œsophageal pump is composed of three main sides, while in the present species it consists of four main sides, as shown in the text figure.

The salivary system (text fig. 1) consists of the paired pyriform glands (*sg*), paired short ducts, unpaired long common duct (*sd*), and salivary pump (*slp*). The salivary pump rep-

resents the special dilated part of the common salivary duct and is just caudad of the salivary aperture. In cross section the pump is somewhat crescentic, consisting of the dorsal, convex (in relaxation of the pumping muscles), thickly chitinized wall, and the ventral concave membranous wall as in the basipharynx. In the longitudinal section as shown in the text figure there is a minute fold arising from the ventral wall at the posterior end of the pump, whereas there is no such projection at the anterior end and the wall at this end is continuous with the innermost wall of the mouth concavity. The posterior fold of the pump probably acts as a valve during the pumping action, preventing the backward movement of the saliva. The salivary sclerites of the hypopharynx, such as the salivæ, have not been detected and perhaps they are wanting; if present, they are very much reduced and almost atrophied. The snoutlike and labiumlike projections are merely projections of certain parts of the head capsule and provided only with a pubescence rather longer than on other parts of the head capsule; there is a pair of toothlike projections (*t*) on the distal corners of the former projection. They do not seem to have any morphological homology with the true mouth parts.

The setæ of the head are all slender but vary in length, and their arrangement on the head capsule is as follows: Six pairs of long setæ arranged transversely at the middle of the head capsule or caudad of the compound eyes, two pairs of small setæ on the dorsoproximal surface of the snoutlike projection or caudad of the blunt dorsal projection of the head capsule near the antennal base, four pairs (long and short, arranged alternately) on the meson of the dorsal surface, one pair of long setæ cephalad of the antennal base, one pair of long setæ on the lateral sides of the snoutlike projection, one pair on the distoventral part, and three pairs on the distodorsal margin of the snoutlike projection respectively, two pairs of long setæ on the caudoproximal part of the labiumlike projection or cephalad of the compound eyes, and one pair of small setæ on the caudal margin of the pocketlike mouth concavity or tip of the labiumlike projection of the head capsule. Besides the above setæ, there are two pairs of porelike sensillæ on the ventromeson of the head capsule or caudad of the compound eyes.

Muscles of the head.—On account of the extreme reduction of the external trophic organs, the development of the musculature of the head is very poor. There are only twelve different

muscles (text fig. 1), including those of the antennæ. Special apodemes and tentoria for the attachment of the muscles are not developed.

1. Abductor of the pedicel.—This is a comparatively small fan-shaped muscle arising from the dorsoproximal region of the inner surface of the scape and is attached to the dorsoproximal edge of the pedicel.

2. Rotator of the pedicel.—This slender muscle arises from the mesoproximal region of the inner surface of the scape and is inserted in the ventroproximal edge of the pedicel.

3. Depressor of the pedicel.—This small muscle is located on the side opposite to the abductor. It arises from the ventroproximal region of the scape and ends very near the attachment of the rotator.

4. Depressor of the scape.—This is a comparatively small muscle on the dorsal side. It arises from the inner surface of the vertex and ends on the dorsoproximal edge of the scape.

5. Abductor of the scape.—This is a short muscle on the base of the snoutlike projection. It arises from the laterodorsal wall of the head capsule, extends dorsomesad, and is inserted in the lower edge of the lateral part of the scape.

6. Levator of the scape.—This muscle is almost of the same size as the abductor and also situated on the base of the snoutlike projection. It arises from the laterodorsal wall of the snoutlike projection, extends dorsocaudad, and ends on the ventroproximal edge of the scape.

7. Dilators of the basipharynx.—These are three strong paired muscles, which arise from the dorsomesal wall (frontoclypeus) of the snoutlike projection, extend caudoventrad, and are inserted in the chitinized dorsal wall of the basipharynx through the muscular investment.

8. Muscles of the salivary pump.—These consist of two pairs of small muscles directly arising from the ventral membrane of the basipharynx and are attached to the central region of the chitinized dorsal wall of the salivary pump.

9. Anterior dorsal dilators of the œsophageal pump.—These muscles are found cephalad of the supraœsophageal ganglion, composed of five paired bands, of which each of the middle three pairs consists of two partially fused muscle bands, so that there may have been eight pairs of muscle bands originally. These dilators arise from the dorsal wall of the vertex between the compound eyes, extend ventrad, and are inserted into the dor-

socephalic part of the œsophageal pump passing through the investment of the ring muscles just caudad of the cephalic expansion of the œsophageal pump.

10. Posterior dorsal dilators of the œsophageal pump.—These are a pair of long strong muscles on the caudal region of the head capsule; each is composed of two partially fused muscle bands. Each muscle arises from the dorsomesal part of the occipital region, and passing under the supraœsophageal ganglion extends ventrocephalad to be attached to the dorsocaudal region of the œsophageal pump.

11. Posterior lateral dilators of the œsophageal pump.—These are located on the caudoventral region of the head capsule. Each of these muscles consists of one strong band, which arises from the inner surface of the postgenal region, ventrad of the ocellus, extends mesocephalad, and ends on the ventrocaudal region of the œsophageal pump very near the attachments of the posterior dorsal dilators.

12. Ring muscles of the basipharynx and œsophageal pump.—No specially isolated and independent sphincters have been found, such as those in *Phlebotomus, Simulium, Anopheles,* and *Culicoides.* In the case of the present fly the entire structure of the basipharynx and œsophageal pump is provided with a continuous muscular investment, which consists of a great many ring muscles. This muscular investment is especially thickened on the cephalic region of the œsophageal pump and thinnest on the basipharynx.

THE THORAX

The thorax (Plate 2, figs. 5 to 7) is scantily haired with slender setæ and entirely covered with fine pubescence, extremely elongated, cylindrical in general appearance, subequal in diameter throughout the whole length, and not produced over the head. The cervix (*cc*) is broad, as wide as the head itself, membranous, and without the chitinized cervepisternum and other sclerites. The spiracles of the thorax are greatly atrophied. A phragma along the caudal margin of the mesopostscutellum is highly developed, but other phragmæ are generally obscure or obsolete.

The prothorax is small, consisting of two pairs of notal, one unpaired sternal, and one pair of small pleural sclerites, the whole structure occupying the lateral and ventral sides of the thoracic wall since the dorsal side is intruded deeply by the prolongation of the mesonotum. Of these sclerites two paired

dorsolateral sclerites are lateral halves of the antepronotum and postpronotum, respectively, which are completely subdivided on the dorsomeson by the produced cephalic part of the mesonotum. Each half of the antepronotum (*an*) is closely applied to the cephalic margin of the mesonotum by the intermediation of a very narrow suturelike mesocoria (*mc*) and separated from the other half of the antepronotum of the opposite side by a wide membrane. This sclerite is characterized by the presence of several slender hairs on its dorsal region. Each half of the postpronotum (*pn*) is subtriangular, without conspicuous setæ, and partially located between the antepronotum and mesonotum.

The ventral side of the prothorax is represented by the large, broad, subsquare prosternum (*pst*). This sternum is not divided into the presternum (sternannum), basisternum, and sternellum, and is provided with a pair of long, slender hairs on its lateral margins and a pair of blunt, thickened, triangular projections on the lateral side. These projections are the prosternacoilæ (sc_1), which are derived from the subcoxal element, the laterosternite, for the articulation of the forelegs. On the broad, lateral, membranous area between the pronotum and the prosternum there is a very small triangular sclerite, which is the reduced pleuron (*pp*). The whole structure of the reduced pleuron is modified into the coxacoila (co_1) for the articulation of the foreleg. This coila is probably derived from the episternum alone.

The mesothorax is extremely large, occupying almost the whole portion of the thorax, and especially the notum is deeply produced into the prothorax at the cephalic part and elongated into the abdomen, forming an endoskeleton (en_2) at the caudal part. The mesonotum is divided into three main sclerites; namely, the long scutopræscutum, the small scutellum, and the large postscutellum. The scutopræscutum (sps_2) is elongated and somewhat oval, formed by the complete fusion of the two sclerites, the præscutum and scutum, losing the scutal suture between them. At the cephalic end this sclerite is provided with a pair of small, incomplete, pseudosutural foveæ (*pv*, not the parapsidis). Along these foveæ in various dipterous insects setæ are usually found in variable number, but in this instance they are completely wanting. The supra-alar setal group (*sa*) of the scutopræscutum is always represented by a single small seta in both sexes. The caudal margin of the scutopræscutum is slightly intruded by the scutellum along the middorsal line (*md*). On the lateral margins of the scutopræscutum is a pair

of small blunt projections, which are the reduced medalariæ (ma_2); in this instance these alariæ are far removed cephalad from the wing base and not functional. Other alariæ, such as the cephalariæ and the caudalariæ, are almost atrophied.

The scutellum (su_2) is small, situated close to the caudal margin of the scutopræscutum, and distinctly subdivided into the large median scutulis (*si*) and the small lateral parascutules (*pc*). The scutulis is somewhat pentagonal and provided with two pairs of long marginal and one pair of small median setæ in both sexes. The endoskeletons of this sclerite are more developed than those of the other sclerites and consist of two kinds of phragmæ. The cephalic endoskeleton, the paraphragma (*pa*), is formed by the infolded cephalic margin of the mesoscutellum, and the paired lateral endoskeletons (*la*) are formed by the ental thickenings along the sutures between the scutulis and parascutules. The parascutulis is small, and extended laterad, forming the scutalaria (*s*) for the articulation of the wing. From the caudolateral angles of the scutulis the paired spirales (*sl*) arise, and each extends laterad along the caudal margin of the parascutulis.

The postscutellum (pl_2) is extraordinarily developed and the caudal half of the thorax, including the dorsal, lateral, and the major parts of the ventral side, is occupied by the extremely expanded postscutellum. This large postscutellum is divided by one pair of distinct sutures into the median mesascutella and lateral parascutellæ. The mesascutella (m_2) is somewhat shield-shaped and widely separated from the scutellum by the membranous coria, and its caudal one-third (en_2) is deeply infolded caudoentad into the abdomen. The surface of the mesascutella is covered with a common fine pubescence, but lacks setæ, and there is a faint inverted V-shaped transversal stripe (*st*) on its meson, although this stripe has apparently no morphological significance. Each parascutella (ps_2) is broad, extended laterad and then ventromesad, directly demarcated by the pleurotaxis on its dorsocephalic margin, connected with the sternum by means of a narrow sternal membrane, and its cephalic prolongation completely separates the preceding epimeron (em_2) into the notepimeron (n_2) and sternepimeron (se_2) by a deep intrusion. The caudal margin of the parascutella is infolded entad and forms a narrow phragma along the round caudal margin. On the ventral side along each mesal margin of the parascutella is a small semichitinized sclerite, which is tentatively designated the parasternite (*pt*) of the mesothorax.

The pleural region is much narrowed by the extreme extension of the parascutella and the major parts are moreover completely reduced to membranous areas, so that the sutures are all obscure. The episternum (et_2) and epimeron (em_2) are divided by the incomplete, slightly undulated, pleural suture (p_2), which starts from the dorsal point of the pleuron, extends between the episternum and notepimeron, around the cephalic prolongation of the parascutella, and ends on the ventral margin of the pleuron near the mesocoxa fossa (c_2). The episternum is only chitinized on its ventral marginal area and its dorsal notepisternal region, and the episternal suture is completely wanting. The chitinized notepisternal region (Plate 4, fig. 13, *ns*) is very small and closely associated with the notepimeron (n_2) and the pleuralifera (*pr*), forming a projection for the articulation of the wing. The membranous sternepisteral area is provided with several indefinite folds, which are not true sutures. There is a large membranous area between the postpronotum and the mesoscutopræscutum or cephalad of the mesosternepisternum. The epimeral region (em_2) is widely separated into the notepimeron and sternepimeron by the cephalic prolongation of the parascutella (ps_2), as already mentioned. The notepimeron (n_2) is thickly chitinized, small, oval, and closely associated with the independent sclerite, the pleuralifera, and the notepisternal area on its dorsal margin and ventrocephalic margin, respectively. The sternepimeron (se_2) is located between the parascutella and the sternal membrane. The coxacoila of the mesopleuron is completely wanting in this instance.

The sternum is located on the broad membranous area, separated from the prosternum by a mesocoria at the cephalic end, and very widely separated from the metasternum by a broad metacoria. The mesosternum itself is divided into two sclerites, the presternum (prs_2) and the basisternosternellum (bs_2 and sm_2) by a distinct, membranous, secondary, transternal suture (*ss*). The former sclerite is cordiform, as large as the prosternum, clearly demarked, and thickly chitinized. Along the caudal margin of this sclerite is a narrow secondary phragma. On the membranous, secondary, transternal suture is a pair of small setæ; these setæ are definitely present in both sexes, although they are very difficult to detect as they are very slender. The basisternosternellum is elongated, and its demarcation is very obscure as it is reduced to a membrane but is

more or less chitinized on its cephalic and mesal parts. The cephalic part of this sclerite is provided with a pair of tiny thickened sternacoilæ (sc_2) on its lateral sides and a small membranous triangular incision (bs_2) on its meson. This small area is the basisternum proper, and the remaining large area is the sternellum proper. The midventral suture (*ms*) is clearly marked throughout this sclerite and more or less thickened entad, and the endoskeleton is very weakly developed along this suture.

The metathorax is very much reduced and represented only by certain parts of the pleuron and the chitinized sternum. The metanotum is completely obsolete. The pleuron is reduced to a membrane, and only a small, slightly thickened area (em_3) is found close to the abdomen or caudoventrad of the base of the haltere (*h*). The sternum is represented by a large, clearly demarcated sternellum (sm_3). This sclerite is similar in structure to the mesosternellum fundamentally, although it is larger, broader, and more thickly chitinized than the latter, being provided with a pair of tiny sternacoilæ (sc_3) on its cephalolateral corners, the midventral suture (*ms*) on its meson, and a pair of slender setæ [2] near the coilæ. The endoskeleton of the sternum is represented only by a narrow phragma along the caudal margin of the sternellum. The metabasisternum is completely reduced into a common membrane continuous with the ventral membranous region of the preceding thoracic segments.

THE WINGS

The wings (Plate 4, fig. 12) are snowy white in life, and at rest they are held dorsad, side by side, perpendicular to the long axis of the insect. They are extremely peculiar in structure, large for the size of the body, very much elongated, fully as long as the body or longer, and about 5.7 times as long as the widest portion of the wing itself, being about 2 to 2.5 millimeters, triangular, entirely without the anal lobe, and therefore the three margins [costal (*cm*), anal (*am*), and outer (*om*)] of the wing are almost straight, the ratio between them being 188 : 115 : 83. The distal angle of the wing in the male is slightly sharper than in the female. There are no macrotrichiæ on any part of the surface, not even on the veins, but the entire margin of the wing, except for the proximal part, is thickly

[2] These setæ had not been detected when the previous taxonomic report was made (1932).

fringed with very long delicate hairs, and the whole membrane is covered with minute microtrichiæ.

These marginal hairs are all milky white in reflected light, but pale brown under transmitted light. Those on the costal margin are somewhat stronger in structure and sparser in arrangement than those on the caudal margin and about half as long, and gradually decrease in length distad on the distal quarter of the costal margin; they are arranged in two lines alternately; those on one line are erect cephalad, while those on the other line are more or less bent distad. The fringe on the caudal margin (anal and outer margins) is very long, being fully 1.5 times as long as the widest portion of the wing itself, and most thickly arranged on the middle part of this margin; most of the hairs are arranged in a single line, being erect caudad, but the minority of the hairs on the outer margin is somewhat bent proximad, and at this part the fringe very gradually decreases in length distad.

The venation of this insect is very much reduced, being represented only by a few veins of slight thickening, most of them located on the proximal quarter of the wing area and ending on the costal margin. Vein C is broad and pale brown under transmitted light, the ambient vein (*av*) extends along the entire caudal margin of the wing and is as distinct as in the costal margin and about half as broad as the costa. Very slight thickenings of the membranes faintly indicate some of the other veins. The proximal broad part of the costal margin shows a double nature, being provided with a shallow longitudinal furrow; this double nature may be assumed to have been induced by the incomplete coalescence of the two veins C and Sc on this part. The most distinct is R_1 and the stem of R combined which terminates on C at about the proximal quarter of the length of the costal margin and is provided with about two placoid sensillæ (*ps*) on the proximal end of R. The other vein, terminating on C a little beyond the end of R_1, is Rs, which is almost atrophied on its proximal half, although faintly connected with the very slightly thickened small Rs, which is located at the middle of the distinct vein R. Cu is rather obvious, extending along the anal margin of the wing, nearly parallel to it, and almost atrophied before the wing margin. The other vein, probably M, is very faint and creaselike, located independently or freely but in the definite position on the middle part of the wing without connection with the other veins, being

completely atrophied both on its proximal and distal terminal parts.

THE LEGS

The legs (Plate 3, figs. 8 to 10) are uniformly pale yellow, very delicate in structure, slender, but comparatively short for the body length, very scantily haired with slender setæ, similar in structure and subequal in length, except that the forelegs are slightly longer and the hind legs shorter than the others. The three pairs of legs are very widely separated from each other and the distances between the fore and middle legs and the middle and hind legs are about equal to each other, being slightly more than the greatest width (on the scutellar region) of the thorax; the forelegs are articulated far dorsad of the usual ventral position, while two pairs are articulated in the normal ventral position.

The coxæ (*cx*) are unusually elongated, neither cylindrical nor conical, but somewhat flattened, and subdivided into the small proximal (*p*) and large distal (*d*) portions; the fore pair is somewhat stouter than the others. Each coxa is provided with several slender and a few curly hairs on the distal end and one to three slender setæ on the middle part. The chitinized proximal subdivision is very narrow, quite cylindrical, distinctly bounded by a narrow, ringlike, membranous, basicostal suture (*mc*) from the main division of the coxa, provided with two groups (one each on the cephalic and caudal side) of microscopic erect setæ; the proximal subdivision of the fore coxa is far shorter than that of the others. The distal margins of the coxæ are more or less incised triangularly on the dorsal sides; this incision of the fore pair is larger and deeper, and that of the hind pair is smaller and shallower than that of the middle pair.

The trochanters (*t*) are elongated, articulated to the coxæ with the distinct trochacoriæ (*to*), quite cylindrical, and provided with two to four slender setæ, and two isolated and one double placoid sensillæ (*sn*) on the distal part. Both ends of the trochanter are more or less chitinized; the proximal chitinization is larger than the distal, being provided with small trochantes (*ta*) against the trochacoilæ (*tc*) and the distal margin is very narrowly chitinized along the femasuture (*fs*). The anterior two trochanters are about half as long as the corresponding coxæ, while the hind trochanter is slightly shorter

than the hind coxa. The fore trochanter is shortest and stoutest, while the hind trochanter is longest and slenderest, being 1.3 times as long as the former.

The femora (*f*) are largest among the leg segments, more or less flattened and swollen on the distal part, subdivided into three parts; namely, the small proximal part (*p*), the membranous intermediate part (*mf*), and the large distal (*d*) part, being immovably articulated to the trochanters. The proximal part is very small and quite bare except for a common fine pubescence, and at this point the femur is distinctly narrowed, especially on the fore and hind legs. The intermediate membranous part is broad, ring-shaped, fully twice as large as the proximal part, quite smooth, hyaline, and provided with several placoid sensillæ (*sn*) on its ventral side. This part of the femur is slightly flexible. The distal part is large and fully twice as long as the two proximal parts taken together, with five slender marginal setæ, besides long setæ (four each on the anterior two femora and one on the hind); its distal margin is distinctly thickened, forming a pair of tibiacoilæ (*tbc*) (one on each lateral side) and sharply incised V-shaped on the ventral side. The fore femur is shortest and somewhat stouter than the others, and the hind femur is longest and slenderest, but about twice as broad as the trochanter. The fore femur is about 1.5 times as long as, and each posterior femur about twice or a little more than twice as long as, the corresponding trochanter; or the anterior two femora are a little shorter than, and the hind femur is subequal to, the preceding two segments (coxa and trochanter) taken together.

TABLE 1.—*Nymphomyia alba Tokunaga; relative lengths of the leg segments.*

[69 units = 0.2 mm.]

Leg.	Coxa.	Trochanter.	Femur.	Tibia.	Tarsus. 1st.	2d.	3d.	4th.	5th.	Total.	Claw.
Fore	39.5	21.3	50.1	56.2	31.0	19.0	15.0	13.5	34.0	272	14.0
Middle	45.0	25.4	55.3	53.8	26.0	20.2	15.8	11.5	28.1	266	12.7
Hind	32.8	27.9	56.0	51.5	19.7	15.0	12.0	12.0	18.6	227	11.0

The tibiæ (*tb*) are elongated, subequal in length to the corresponding femora, cylindrical and slender, except those of the middle legs which are somewhat swollen on the distal parts, and each tibia is subdivided into three parts (proximal, membra-

nous, and distal) like the femora. No tibia shows any trace of an apical spur or any spurlike projection. The articulation between the femur and tibia is strong, being provided with a thickly chitinized coila (*tbc*) and artis (*tba*) on each side, but rather simpler than the hypothetical articulation of the insect leg in losing such structures as the tibiaflexis, fematroclia, and patella. The proximal parts (*p*) of all pairs are small, without setæ, and subequal in diameter; those of the anterior two pairs are somewhat curved ventrad and each is about one-fifth as long as the tibia itself, while those of the posterior pair are more or less elongated, nearly straight, and about one-third as long as the hind tibiæ. The membranous parts (*mt*) are subequal in length, quite smooth, hyaline, and considerably enlarged on the flexor ventral surface; those on the anterior two legs are subequal in length to the proximal parts, respectively, and slightly greater in diameter; while on the hind legs these parts are subequal in diameter to the proximal parts and only half as long. The tibiæ are very slightly flexible and usually bent ventrad at these membranous parts, as in the femora. The distal parts (*d*) of the three pairs are considerably different in shape and length, but similar in structure to each other; they are each provided with one to three placoid sensillæ (*sn*) on the proximodorsal surface, three or four slender setæ scattered on the proximal half, and four or five slender setæ on the distal end. Concerning the relative length and size, this part of the foreleg is slenderest and longest among the three tibiæ, being very slightly greater in diameter than in the proximal part and about 2.5 times as long as the proximal two parts taken together. The distal part of the middle tibia is large and stout, being more than twice as broad as the proximal part and nearly twice as large as the distal part of other tibiæ, but far shorter than that of the fore tibia and subequal in size to the distal part of the hind femur. The distal part of the hind tibia is quite cylindrical, as in the fore tibia, and subequal in diameter to the latter, but far shorter and shortest among those of the three tibiæ, being only about half as long as the fore tibia itself.

The tarsi (*ts*) are all five-segmented, slender, and very scantily haired with a few minute setæ only on the dorsodistal end of each tarsal segment. Each of the third and fourth segments on all the legs is provided with an unpaired microscopic spine (*tp*) on the ventrodistal end. The articulations of the tarsal segments are more or less oblique, and there are a rather extensive membrane on the flexor surface and a tarsaflexis and

tarsatroclia on the extensor dorsal side between most of the segments. Each tarsal segment is somewhat enlarged on the distal part, the ventral surface of which is thinner in structure than the dorsal. The basal and ultimate tarsal segments on the same legs are nearly equal in length, and the proximal four segments are gradually shortened distad. The fifth tarsal segment, especially on its distal part, on all the legs is somewhat more pubescent with long microtrichia than the other parts and provided with the ordinary terminal structures but shows no trace of the pulvilli. The ratio in the length of the three tarsi is about 103 : 93 : 66, and thus the long forelegs possess long tarsi and the short hind legs have short tarsi, but the proportion in the length of each tarsus and the leg to which it belongs is quite different in the different pairs. On the foreleg the first tarsal segment is about half as long as the tibia and scarcely as long as the two following segments together. The first tarsal segment of the middle leg is also about half as long as the tibia but shorter than the following two segments taken together; the ultimate segment is subequal in length to the first tarsal segment and fully as long as the two preceding segments together. The tarsal segments of the hind leg are slightly stouter than those of the other legs; their articulations are distinctly oblique and each segment is far shorter than the corresponding segments of the other legs. Each of the first and ultimate segments of this leg is slightly longer than one-third of the tibia, or only slightly longer than half of the corresponding segments of the foreleg. Among the remaining three tarsal segments the third and the fourth are nearly equal in length, the total length of the above two segments being somewhat greater than the ultimate segment, and each segment is slightly shorter than the second tarsal segment.

The claws (*c*) are symmetrical in structure, slender and sharply pointed, quite glabrous, unserrated, not quite smooth, but with very fine oblique striation on the lateral side. The empodium (*e*) is elongated and slender, slightly shorter than the claws, and provided with many simple hairs. The calcanea (*cn*) is also slender, finely squamous, and without the onychium. The last two structures are directly fused with each other, losing such structures as the planta and auxilia. The tubercula (*tu*) is not distinctly projected distad between the claws, but thickened and emarginated ventrad, forming the "Glenkhöcker" (*gh*) against which the claws are articulated.

THE ARTICULATIONS OF THE LEGS, THE WINGS, AND THE HALTERES

The articulations of the legs are all very simple, and all the coxafossæ are very small. The forelegs are articulated laterally and widely separated from each other; each foreleg is provided with the coxartis, which articulates against the coxacoila, but is without the distinct sternartis. The middle legs are articulated ventrally, each with the sternacoila, and the distance between the middle legs is least among the three pairs. The hind legs are also articulated ventrally with the sternartis against the sternacoila, but without the coxartis and the coxacoila as in the middle legs. The distances between the three pairs are subequal and very long, due to the elongation of the thorax (Plate 2, figs. 5 and 7).

The articulation of the wing is very complex (Plate 2, fig. 5; Plate 4, fig. 13). There are four aliferæ on the pleurotaxis for the articulation of the wing; namely, the prealifera, medalifera, subalifera (pleuralifera), and postalifera. The micralifera is completely wanting. The prealifera (*pal*) is small, thickly chitinized, and located on the dorsal part of the broad lateral membrane. The medalifera (*ml*) is oval, slightly chitinized, and located between the prealifera and the notepisternum, and its cephalic part is attached to the prealifera. The subalifera (*pr*) is very thickly chitinized, somewhat C-shaped, and forms a strong main projection for the wing base, being closely associated with the dorsal projection of the notepisternum (*np*) and the notepimeron (n_2). The postalifera (*pol*) is oval, thickly chitinized, and located closely near the cephalodorsal margin of the parascutella (ps_2), and the spiralis (*sl*) is extended along the cephalodorsal margin of this sclerite.

Dorsad of the prealifera or near the costalis there is a small spinous tubercle which is the mesotegula (te_2). Besides these sclerites, along the lateral margin of the scutopræscutum (sps_2), there is a narrow, rod-shaped sclerite which is the ponta (*po*). The ponta forms a small, irregularly shaped structure at its caudal end which is complexly articulated to the prealifera, the subalifera, and the costalis.

The pteraliæ (Plate 4, fig. 13) are reduced in number, being represented only by the following distinct sclerites: Terminalia (duritæ), costalis, radialis, and analis (venellæ). Such duritæ as the sigmoidea, submedia, and navicula, and such funditæ as the costalla, mediella, and anella are almost completely atrophied.

The terminalia (*t*) is located between the subalifera (*pr*) and the postalifera (*pol*) and closely associated with the analis (*as*). The costalis (*cs*) is largest among the three venellæ, and the radialis (*ra*) is very small, somewhat lunate in shape, and anastomosed into the costa on its distal part. These two venellæ are articulated directly to the pleuralifera and the caudal end of the ponta.

The notal processes for the articulation of the wings are greatly reduced. The medalaria is blunt and minute, far separated cephalad from the wing base, and has no direct mechanical relation with the wing movement. The scutalaria is also minute and situated close to the costalis. The caudalaria is obscure. The other alariæ are all completely atrophied.

The articulation of the base of the haltere (Plate 3, fig. 11) is very simple. The spherical proximal end, the scabellum (*sc*) of the petiole (*ptl*), is directly articulated to a swelling of the rotaxis (*bsr*). This basal swelling is homologous with the region where the various basal sclerites, such as the funditæ, venellæ, and perhaps the duritæ, may be found in the generalized wing base. At the cephalic region of the rotaxis (*r*) is a blunt membranous projection which is covered with distinguishable pubescence. This projection is the remnant of the metategula (te_3). The pteraliæ, the alariæ, and the spiralis are obscure.

THE ABDOMEN

There are almost no sexual differences in the structure of the abdomen excepting the ultimate and penultimate segments. The abdomen of both sexes is pale yellow, feebly chitinized, slender, extremely elongated, and at rest slightly curved ventrad; superficially with nine distinguishable segments, including the hypopygium, quite cylindrical, the diameter nearly uniform throughout the whole length, covered with a fine microscopic pubescence, scantily haired with slender setæ and with a few scattered transparent patterns, brown tubercles, and various sensillæ on each segment. There is no trace of spiracles (text fig. 2).

The segments of this insect, except the first and two terminal segments, as a rule, are not subdivided into intrasegmental annulets, but provided with cuticular structures, as follows: The transversal thickening, which serves as an "antecosta" (*ac*) of the intersegmental muscles and becomes hidden in the intersegmental fold on contraction of the muscles, is located across the tergum closely along the cephalic margin, narrowed and highly chitinized on its mesal part but somewhat broad and thin

on its lateral parts. On the sternum there is no corresponding thickening. The distinct tubercules (*tb*) are arranged transversally on the caudal region of the tergum; the number of the tubercules is very irregular, varying from one to five pairs, and they are less in number on the cephalic abdominal segments than on the caudal; and, moreover, the male is provided with more of them than the female. Very close to the above tuber-

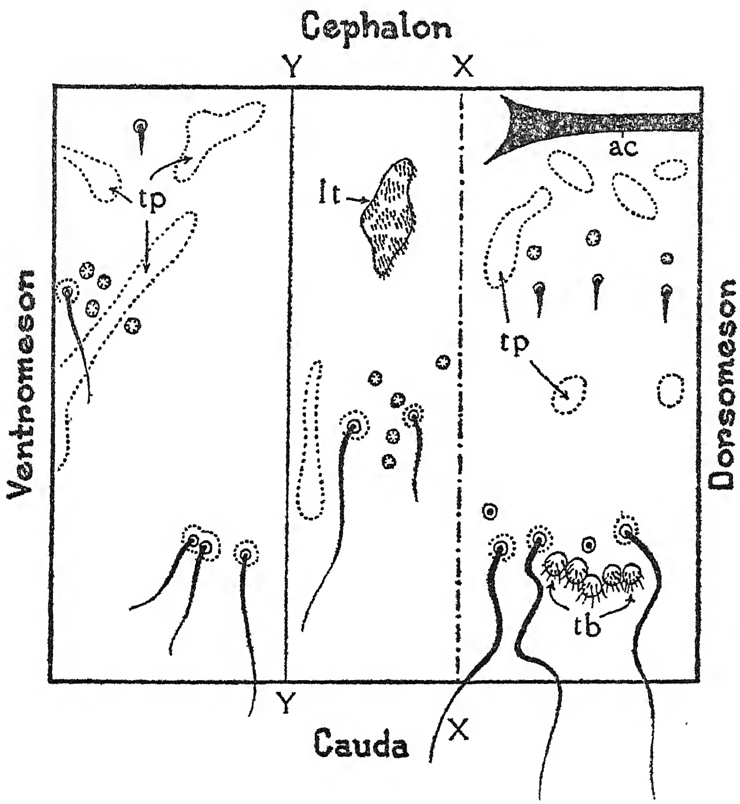

Fig. 2. Diagrammatic arrangement of the cuticular structures of the abdominal segment. *ac*, Antecosta; *lt*, lateral tubercle; *tb*, tubercule; *tp*, transparent pattern; *X–X* tergoparatergal line; *Y–Y*, tergopleural line.

cules are three pairs of long, slender, brown setæ and two pairs of minute sensillæ. The transparent patterns (*tp*) are scattered on the tergum; two pairs of them, which are round, are on the middle region, and four pairs located on the cephalic region or caudad of the cephalic thickening are somewhat oval, the lateromarginal pair being more elongated. Between the two groups of the transparent patterns are about six pairs of sensillæ; the cephalic three pairs are placoid, and the caudal three are trichoid.

On the lateral side, where the paratergal sclerites are located in certain insects, is a large, somewhat elongated tubercle (*lt*) on the cephalic region where the spiracle would be expected. This tubercle may be derived from the modified peritreme or other paratergal elements. Two slender setæ, one long and the other short, are located on the middle region of the lateral side where there are several minute placoid sensillæ. A large, elongated, transparent pattern is found ventrad of these setæ.

The pleural region, ventrad of the dorsopleural groove (*Y–Y*), is uniformly membranous with the sternum completely losing the pleural sclerites.

The sternum is not provided with tubercles and tubercules. There are about three pairs of slender setæ in the caudal region corresponding to those on the tergum. The cephalic region of the sternum is provided with two pairs of small setæ, of which the anterior pair is very small, hyaline, and may be trichoid sensillæ; the others are located near each other on the meson of the sternum. The transparent patterns of the sternum are large; a very large V-shaped pattern is located on the meson, a united or paired pattern on the mesocephalic margin, and a paired one on the laterocephalic margin.

The first abdominal segment is somewhat more elongated than the others, subdivided into two annulets on the dorsal side, bearing several pairs of strong setæ on the dorsocephalic margin, usually two pairs of slender setæ and about one pair of tubercules on the dorsocaudal region, two small setæ on each lateral side, and a large V-shaped transparent pattern on the ventral. The various other structures of the cuticule as shown on the other segments are very obscure or wanting.

THE TERMINAL ABDOMINAL SEGMENTS OF THE FEMALE

The terminal two segments (Plate 4, figs. 14 to 16) are very different in structure from the preceding segments, and the sexual differences are shown most clearly on these segments.

On the eighth, penultimate, segment of the female the tergum (*ot*) is broad, uniformly chitinized, thickly pubescent, and provided only with three pairs of slender setæ on the caudal region, one pair of minute trichoid sensillæ on the cephalic region, and two pairs of transparent round or oval patterns on the cephalolateral corners; the cephalomarginal thickening is very feebly developed, and the placoid sensillæ are quite obscure. The sternum (*os*) is almost membranous and covered with rather long pubescence; the cephalomesal region of the sternum is

swollen ventrad, while the caudomesal region is suddenly depressed dorsad. The cephalic margin (*at*) of the sternum is chitinized broadly and usually hidden in the intersegmental fold. Along this margin is a thin antecostal lamella. Along the midventral line the swollen region is folded or doubled up deeply entad, forming a large but thin, chitinized, lamellalike endoskeleton (*ec*). These two endoskeletons serve as attachments of the various genital muscles. On the caudal half of the sternum or on the lateral margin of the depressed region there is one pair of distinct long setæ accompanied by three or four pairs of minute trichoid sensillæ very near each other. The caudal margin of the eighth sternum is folded dorsocephalad, forming a large membranous genital chamber (*gc*) between this segment and the ninth. In the innermost part of the genital chamber is the common aperture of the sexual glands, guarded by a slightly chitinized lunulate endapophysis (entogonapophysis or paramere). The lateral sides or the paratergal region (*pt*) of the eighth segment is quite characteristic in structure. The whole structure is more or less thickened and hangs down from the lateral margin of the tergum proper along the lateral side of the segment, forming a longitudinal tergopleural fold. The caudal part of this fold (*pj*) is extremely elongated ventromesad along the caudal margin of the sternum to form a cover of the genital chamber, and is provided with a conspicuous long seta on its basis. Besides this flattened caudal projection there are two distinct tubercles (*t*) on the tergopleural fold; one situated on the cephalic margin of this fold is thickened and large, while the other is somewhat small, provided with a minute seta, and located on the ventral margin of the fold or just caudad of the former tubercle.

The terminal region, including the ninth segment, caudad of the eighth segment, is small, about half as long as the preceding segment, and quarter-spherical in shape. The dorsal half of the spherical surface, the ninth segmacoria (*sc*), is very broad, membranous, and without setæ. The ventral half is more or less thickened, without tubercles and setæ, but with a pair of large cylindrical projections on the ventrocephalolateral corners. This projection, the cercus (*ce*), is not articulated but firmly fused to the body wall, bears many setæ, and with the nonfunctional remnant of the special muscles. At the basis of the cerci, on the membranous sternum and along the entrance to the genital chamber, is a pair of small, blade-shaped, and setigerous sclerites (*cc*), which are the cercariæ. The ventral side is mainly

membranous, except for the lateral margins (*ep*), which are a part of the tergum. On this part are four very long setæ, one of which is projected caudad, while the other three are directed ventrad. The ventral membranous area is rugous and subdivided into two regions, the cephalic and the caudal; the cephalic region (*pp* and *sa*) is somewhat swollen ventrad, while the caudal (*su*) is flattened. The anus (*a*) is located between these two regions.

THE TERMINAL ABDOMINAL SEGMENTS OF THE MALE

The penultimate and ultimate abdominal segments of the male (Plate 5, figs. 17 to 19) are highly modified and differ greatly in structure from those of the female. The eighth, or penultimate, segment is somewhat smaller than the preceding seventh, and not provided with the tubercules on the dorsocaudal region but with paired transparent patterns on the ventral surface. The cephalic margin (*at*) of the eighth tergum (*ot*) is narrowly and thickly chitinized and provided with a pair of small transparent patterns on the lateral parts of this chitinization. Besides the above small patterns there is a pair of rather large transparent patterns on the cephalic region of the tergum or caudad of the cephalic chitinization. On the middle part of the tergum are two small trichoid sensillæ, and on the caudal region three pairs of long slender setæ are transversally arranged. The caudal margin of the eighth segment is very thinly membranous and without microtrichia. The sternum (*os*) is somewhat thinner than the tergum and more scantily covered with rather long pubescence. On the cephalic region of the sternum are large, transparent, paired patterns and small trichoid sensillæ, and on the caudal region is one pair of long setæ. The lateral paratergal region (*pt*) of the eighth segment is provided with two, large, peculiar processes, which are subequal in length and parallelly extend caudad as far as the caudal margin of the eighth segment. The dorsal (pj_1) of these two projections is entirely covered with fine microtrichia and provided with a long seta on its ventroproximal part and with two small thickened tubercles (*t*), which are quite bare and situated close to each other on the ventroproximal base. The ventral projection (pj_2) is slenderer than the dorsal, quite bare, uniformly and thickly chitinized, and provided with a hooklike point at its distal tip. On the ventroproximal base of this projection is a large, smooth, earlike thickening (*t*), which is somewhat thin, convex laterad, and concave mesad. The above two

(dorsal and ventral) large projections are not independently movable, but work in union, being firmly fused to the common thickening by the common tergosternal muscles. At rest these two projections are closely situated along the body wall, but when the common thickening is pulled ventrad by the contraction of the tergosternal muscles, they can be extended horizontally or nearly so. The lateral surface of the eighth segment, besides the above distinct processes, is provided with two long setæ on the blunt colliculus and a small trichoid sensilla on the mid-lateral region. On the ventral side, between the eighth and ninth segments, is a very large membranous ædeagus (*aa*). The ædeagus is quite smooth, without pubescence, directly exposed externally, and supported by a chitinized framework (*pa*), the ectapophysis (gonapophysis or paramere), which subdivides the membranous region into two parts. The proximal region (*pb*) is very broad and as wide as the eighth segment itself, while the distal region (*p*) is very small and blunt.

The ultimate segment consists of the ninth and other posterior segments, paired large cerci, and coxites. This fused segment is very small and about a quarter as large as the preceding eighth segment; its dorsum is rather thinly membranous and covered with delicate pubescence; its venter is very thin and very scantily pubescent, and the macrotrichia is quite wanting on both surfaces. The cerci (*ce*) and coxites (*cx*) are firmly fused to this segment, and the demarcation between them is almost wanting. The cerci alone are distinctly demarcated only on the ventral aspect by the presence of the cercariæ (*cc*). The cercus is located dorsad of the coxite, extended ventrocaudad, setigerous on its dorsal side, and very scantily haired on its ventral side (*pp*), hairs being represented only by two long setæ, one on the proximomesal part and the other on the middle part. The basis of the cercus is very broad with a very long seta on its dorsomesal margin, while the distal part is sharply pointed and with many short setæ. The cercaria (*cc*) is very slender but distinct, claw-shaped, somewhat thickened, and quite bare. The coxite [3] (*cx*) is very conspicuous, broad at its base, occupying the greater portion of the lateral aspect of the ninth segment, but slender on its distal half, extending caudad as far as the cercus, and gradually curved ventromesad. The entire surface of the coxite is covered with common pubescence,

[3] The coxite is homologous with the subcoxa of the leg-bearing segment or with the limb base of the stylus and is commonly known as the "side piece."

but without any kind of macrotrichia. Its ventral ridge is provided with two rows of thick recurved pubescence along its entire length. The style[4] (*s*) is very small and slender, somewhat curved laterodorsad and directed cephalodorsad. It is covered with common pubescence and without macrotrichia, not chitinized, and without chitinized hooks or claws. At the articulation of the style is a blunt lobe (*h*), which is also without setæ and covered with common microtrichia. This swelling is homologous with the so-called "harpe" of various nematocerous Diptera. The periproct (*sa* and *su*) is closely fused to the paraproct on the ventral side and situated at the caudal end of the abdomen between the cerci.

DISCUSSION

THE HEAD

Although the head of this fly is quite peculiar in the structure of all of its parts, its most extraordinary features are the prolongation of the head capsule, the complete reduction of the mouth parts, and the lateral position of the large ocelli.

In the Diptera the elongation of the head is of two types, representing two independent lines of evolution. The first type is derived from the modification of the mouth parts; the theca, which is homologous with the labial stipula of the generalized insect, is the main structure participating in the realization of this type. This sclerite often seems to take part in the formation of the head capsule, being located on the opposite side of the frontoclypeus and associated with the stipes. In various Diptera, such as the Culicidæ (*Psorophora*), Asilidæ, Cyrtidæ (*Eulonchus*), Conopidæ, Muscidæ (*Glossina* and *Stomoxys*), Tachinidæ (*Archytas*), etc., the elongation of the head is solely due to the elongation of the theca and accessory membrane. In various insects with extremely long probosces, such as the Culicidæ (Culicinæ), Tipulidæ (*Geranomyia* and *Elephantomyia*), Empidæ (*Empis*), Bombyliidæ (*Bombylius* and *Exoprosopa*), etc., the exceptional length is accounted for by the presence of the elongated paraglossæ, which, together with the elongated thecæ, augment the length of the proboscis. The second type of the elongation of the head is derived from the modification of the sclerites of the head capsule themselves, and this type is very rare among the dipterous insects, although

[4] The style is homologous with the stylus of the Thysanura and is commonly known as the "clasper."

it is quite prevalent among certain other orders, such as the Coleoptera (Rhynchophora), Hemiptera, Anoplura, Mecoptera, etc. Among Diptera this type is only shown in such nematocerous insects as the Blepharoceridæ (*Bibiocephala*), Culicidæ (*Psorophora*), Dixidæ (*Dixa*), etc., and rarely, if at all, among the higher Diptera, such as Brachycera and Athericera. In these cases the prolongation of the head is mainly due to the elongation and modification of the frontoclypeus.

The head of the present insect, *Nymphomyia*, evidently belongs to the latter type, although it shows many important differences from the other insects included in the same type. Generally the elongation of the head in the second type is due to the cephaloventral prolongation of the frontoclypeus, which is more or less distinctly demarcated from the other sclerites, and the mouth parts become located eventually at the cephalic end of this prolongation. Moreover, the large caudal region, which consists of the vertex and compound eyes, usually retains a spherical shape or is slightly flattened and round. In the present insect the elongation of the head capsule is, contrary to the above, due to the modification of the whole head capsule. The cephalic snoutlike projection (Plate 1, figs. 1 to 3, *sn*), which is not provided with the mouth opening at its extremity, is not demarcated from the common head capsule; but, judging from the attachment of the muscles (dilators) of the basipharynx and the position of the antennæ, it may be homologous with the frontoclypeus or some parts of the frontoclypeus. The head of the female *Bibio* (Bibionidæ) is more or less modified on its cranial region, being slightly elongated and flattened, but the region cephalad of the antennæ, the frontoclypeus, is very small. In this respect the head of *Nymphomyia* is quite different in its constitution from that of *Bibio*. So far as the elongation of the head capsule is concerned, more intimate affinities with the present insect may be found among the most primitive groups of Nematocera, such as the Tipulidæ. Among the Tipulidæ the head of *Tipula* is distinctly elongated cephalad, forming a cylindrical prolongation, which, in turn, bears a distinct snoutlike projection on its dorsocephalic end. This snoutlike projection of *Tipula* is quite independent in structure of the mouth parts and is derived from the frontoclypeus. The mouth parts are located on the cephalic part of the prolongation, just beneath the snoutlike projection. The peculiar cephalic elongation of the head of *Nymphomyia* is easily derivable from that

of *Tipula* if one assumes enlargement of the part of the snoutlike projection of the latter. A peculiar snoutlike structure of *Nemotelus* (Stratiomyiidæ) also may be homologous with that of *Nymphomyia*, but the relative position of its mouth parts is quite different since it is hypognathous in type.

The position of the occipital foramen has the most intimate correlation with the shape of the head capsule. The head, which is round or spherical as shown in the higher Diptera,[5] is almost always the hypognathous type (s. lat., including the orthognathous type); that is, vertical with the mouth parts directed ventrad, and the occipital foramen is located on the caudal aspect. The nematocerous groups are also hypognathous (orthognathous, s. str.), as a rule, but show gradual modification from the hypognathous to the prognathous in varying degree, according to the tendency of prolongation in the head itself. In insects provided with more or less elongated heads, such as *Rhyphus* (Anisopidæ), *Mycetophila* (Mycetophilidæ), and *Bibiocephala* (Blepharoceridæ), the position of the occipital foramen is more or less excentric, having migrated dorsad, and more advanced modification is shown in such flies as the female in *Psorophora* (Culicidæ), the female in *Bibio* (Bibionidæ), etc., which have more-elongated heads. In the extreme case the head exhibits a prognathous type, rather than the hypognathous type, or nearly so, as in *Dixa* (Dixidæ), *Limnobia* and *Tipula* (Tipulidæ), etc. In this respect such a protonematocerous group as the Tipulidæ shows a certain similarity to *Nymphomyia*, but the superficial similarity of these two types of the head is realized independently in various families and genera that have no direct phylogenetic relations between them. It is noteworthy, however, that this tendency is seen only among the Nematocera and not among the Brachycera and Athericera. The above discussion of the head of the present insect indicates that *Nymphomyia* should probably be included in the nematocerous group, although more information is needed to locate its exact phylogenetic position.

The relative size of the occipital foramen is more or less constant throughout the dipterous orders, as shown by Peterson, and relatively small on account of the small cervix. Even in

[5] In certain parasitic groups of Diptera, such as the Hippoboscidæ and the Streblidæ, the head is highly modified secondarily from the hypognathous type, and the extreme case of this modification is shown best in the prognathous head of *Ascodipteron*.

the largest, as in the Psychodinæ, the area of the foramen is far less than a quarter of the caudal surface of the head capsule, while in *Nymphomyia* the foramen (Plate 1, fig. 3, *of*) is extraordinarily large, being nearly as large as the caudal aspect of the head itself. Moreover, the foramen of the Diptera is always provided with a pair of odontoideæ for the articulation of the cervepisterna, while in the present insect these processes are completely wanting, and the margin (*o*) of the foramen is quite smooth. Judging from the structures of the occiput in addition to other parts of the head capsule, the head of this insect shows a closer resemblance to the head capsule of certain eucephalous nematocerous larvæ, such as those of the Chironomidæ, Dixidæ, Psychodidæ, etc., than to the imaginal head capsules, as is evident in the following points: Prognathous in type, large occipital foramen, atrophy of the odontoideæ and the tentoriæ, and complete fusion of the head sclerites. In point of movability the head of *Nymphomyia* is thought to be limited within a narrower range than the heads of the other Diptera, which are provided with a small occipital foramen and well-developed odontoideæ, since the large occipital foramen of the Nymphomyiidæ is connected with the thorax by a very narrow cervacoria. The complete atrophy of the cervical sclerites supports this assumption.

The mouth parts of the dipterous insects usually undergo reduction in the number of the constituent appendages, as exhibited in the hypothetical case, and become more or less membranous as a whole. This reduction and modification occurs in various families and genera of Diptera in different degrees. Atrophy takes place in the mandible, lacinia, and glossa as the first step of reduction, and then in the galea as the second step. Both or either of the paraglossæ and maxillary palpi remain to the last.

Generally the paraglossæ are extremely well developed among the Diptera and constitute the important mouth parts. Even in certain Chironomidæ, such as the genera *Pontomyia* and *Clunio* which have highly reduced mouth parts, the female is provided with a trace of the paraglossæ and the male with tiny but more prominent paraglossæ, as I reported in 1932. So far as I know, except in the case of the parasitic Diptera, the complete atrophy of the paraglossæ is only known in the Deuterophlebiidæ, in which neither sex has a trace of the maxillary palpi or the paraglossæ, and in the present family, Nymphomyiidæ. The maxillary palpi are not reduced and usually have three to five

segments among the Nematocera, while in the Brachycera and the Athericera they are highly reduced or modified and show a nonsegmental condition; but the reduction of the palpus is not very rare even among the Nematocera, and the nonsegmented palpi are often found among certain gall midges and true midges. The complete reduction, as seen in the present insect, however, is very rare in free-living nematocerous insects, and examples are found only in the famous *Deuterophlebia* and the female in *Pontomyia*. As mentioned above, the mouth parts of *Nymphomyia* are closely related to those of *Deuterophlebia*, not only in the degree of reduction but also in the peculiar location of the mouth-opening, which is in the pocketlike chitinized mouth concavity. This cavity (Plate 1, figs. 1 and 2, *mc*) is located on the proximoventral side of the cephalic frontoclypeal projection (*sn*), which in the latter genus is far smaller and blunter than in the former. The labiumlike projection (*lp*) of the present insect is quite unique for the Diptera, and the exact homology of this projection is not yet known, although it might have been derived from such sclerites as the mentum or submentum or, more probably, from the theca or fused stipites, since the latter sclerites are far more stable in the Diptera than the former sclerites.

In spite of the complete reduction of the external mouth parts, the propharynx and the hypopharynx, it seems that the structures of the basipharynx and the œsophageal pump and those of the salivary system retained (text fig. 1) suggest the possibility of a functional action of these organs for taking liquid food. This question is very problematic in the natural life of *Nymphomyia*, because the epithelial layer of the midintestine is completely degenerated, being now represented only by a single delicate membrane, which has lost the characteristic epidermal structures; the thin epithelial cells of the salivary glands are highly reduced, now showing no trace of secretory features (although often the saliva is preserved within the glands of the imago, it may be a remnant of the secretion produced in earlier stadia); and experimentally the fly never takes food offered to it, such as water drops, honey water, sugar water, salt water, etc.

The presence or absence of the ocelli is vastly important for the phylogenetic consideration of the dipterous insects since the distribution of ocelli is strictly characteristic of different phylogenetic lines. All Athericera have three ocelli (except only the Conopidæ, in which the ocelli are wanting). Brachy-

cera also have three ocelli (except only the Tabaninæ, in which the ocelli are usually wanting), and in the pupiparous group both the ocelli and compound eyes are reduced in various degrees. Among the Nematocera the ocelli are present only in certain superfamilies or families, such as the Trichoceridæ, Blepharoceridæ, Mycetophilidæ, Anisopidæ, certain ceratopogonids,[6] cecidomyiid Lestremiinæ, and Bibionoidea. The ocelli (Plate 1, figs. 1 to 3, *oc*) of the present insect are highly peculiar and obscure their true nature, suggesting at first the spiracles or the metatentorinæ. The peculiarity is shown, first, in the complete atrophy of the middorsal ocellus and, secondly, in the lateral position of the extremely large paired ocelli. That these lateral organs of the Nymphomyiidæ are true ocelli is shown by the presence of the lenslike, very slightly biconvex, glassy structure; of the subcuticular pigments, which are regularly arranged in certain limited cells; and in the absence of any trace of tracheal branches and other spiracular structures associated with them that might suggest homology with the spiracles, as well as in the absence of thickened invaginations that might suggest homology with the tentorinæ. Symphyla alone is known to possess spiracles on the head, and no other insect is known to simulate this peculiar location of the first pair of spiracles on the head. The metatentorinæ are often shown on the caudal aspect of the head capsule among insects, and sometimes they become very large, as in the Tipulidæ (*Tipula, Ctenacroscelis,* etc.). From these facts, taken in connection with the other features, these lateral organs may well be considered as ocelli or eyespots. This hypothesis is conclusively supported by the fact that these organs are in direct connection with the strong but short nerve fibers (ocellar nerve) arising from the protocerebral lobe.

There are many examples among the Hemiptera, such as the Henicocephalidæ, the Reduviidæ, etc., where the median ocellus is completely atrophied, and only two ocelli remain conspicuous, but among the Diptera such cases are very rare, occurring only in certain *Mycetophila* (Mycetophilidæ), *Canthyloscelis* (Scatopsidæ), *Oncodes* (Cyrtidæ), and *Culicoides* (Ceratopogonidæ). Although in the hemipterous insects the two ocelli have migrated more caudad or caudolaterad than in the other orders, the ocelli in the Diptera are almost always on the dor-

[6] Jobling, B., Bull. Ent. Res. 18 (1928) 211–236, reported two vestigial ocelli in *Culicoides*.

somedian region between the compound eyes in the dichoptic type, and just caudad of the eyes in the holoptic type. In both cases the ocelli are never as far remote from each other as in the present insect. Besides the above differences of the ocelli between this peculiar insect and all the other dipterous insects, the ocelli in *Nymphomyia* are extraordinarily large, and their structure as a whole is not so compact and solid as in the so-called ocelli. In this respect, as well as in the other features mentioned above, these lateral organs of the present insect appear of somewhat different origin from the ocelli found in the generalized dipterous head, although they have some affinity to the ocelli or eyespots on the massive head of the larvæ of many eucephalous Nematocera, or those found on the adult head of certain Nematocera, such as the marine Chironomidæ. In these cases the eyespots are represented by organized masses of pigment-filled cells, which are almost nonspecialized hypodermal cells communicating with poorly developed nerve endings, as in the larvæ of *Ceratopogon,* shown by Hesse, where no corneal layer, eye lens, or vitreous layer is differentiated differing from the highly developed primitive ocelli. The hypodermal pigmental masses of the adult head, as shown in the Chironomidæ, are never located in the position of the primary ocelli of the Diptera, but are usually found on the lateral aspect, as in the larval eyespots mentioned by Saunders in *Paraclunio* and by Tokunaga in *Clunio* and *Telmatogeton.* In the female *Pontomyia* these pigmental spots have migrated far ventrocephalad, being situated on the cephalic aspect of the flattened head or ventrad of the compound eyes, and each occupies a fairly large area. The anomalous position of these pigmental masses, in addition to their structures, suggests a certain relationship between the lateral organs of *Nymphomyia* and the eyespots of the above-mentioned insects. Although Saunders suggests that the pigmental spots on the head of *Paraclunio* are some organs other than the ocelli, since they are not accompanied by the definite nerve, since the whole of them are subcutaneous, and since the hypodermis passing over them is unbroken, it is very difficult to compare such primitive organs as the eyespots with the ocelli found on the adult heads or on the heads of nymphs and naiads. Moreover, the nerve system communicating with the eyespots is not always so distinct as in the true ocelli, and it probably is represented by very fine neurofibrillæ, as in the peripheral nerve system, which are almost impossible to demonstrate by the usual histological technic. As previously noted,

the so-called "ocelli" of the *Nymphomyia* are thought to be different in origin from the primary or dorsal ocelli of insects, and may be more closely related to the eyespots or larval adaptive ocelli of the nematocerous larvæ or those of certain adult midges.

The antennæ of the present insect (Plate 1, fig. 4) are quite brachycerous in type in their general appearance and in the reduction of the flagellum segments. The antennæ of the Diptera, as a whole, show a wide range of development, but in the majority of the genera the main line of specialization is toward the reduction of the flagellum segmentation. On the other hand, the scape and the pedicel undergo only a slight change. Examples of the simple reduction in the number of the flagellum segments are found even among the nematocerous Diptera, such as the females of certain genera of the Chironomidæ and both sexes of the Deuterophlebiidæ, but in all these cases, although the length or size is more or less divergent, the differentiation among the flagellum segments is very slightly developed, and all the segments of the antennæ are subequal in shape and structure as shown in *Tanytarsus, Chironomus, Pentapedilum, Deuterophlebia,* etc. The segmental differentiation of the flagellum of the Nymphomyiidæ shows rather a closer similarity to that of the Brachycera, especially the Empidæ, than to that of the Nematocera, but this similarity of the antennæ is not thought to represent a direct phylogenetic affinity between the present family and the Brachycera. On the other hand, the presence of the intersegmental sensillæ (Plate 1, fig. 4, *is*) on the flagellum in the present insect is quite peculiar among the adult antennæ of the Diptera, since the various sensillæ found are always located on the segments themselves and never on the intersegmental coriæ, although the intersegmental sensillæ are very common in the larval antennæ. As mentioned above, it is noteworthy that the Nymphomyiidæ, which show many primitive nematocerous characters, are provided with peculiar antennæ whose appearance is strongly suggestive of the antennæ of the higher Brachycera, although they are not absolutely identical with the latter.

The antennariæ of the Diptera are more or less closely united with the common head capsule, and their demarcations generally become obscure, both in the Orthorrhapha and the Cyclorrhapha. Their independent existence is plainly shown only in certain limited families or genera of the nematocerous groups that are

provided with large antacoriæ or accessory membranous areas; such as, the Tipulidæ, Chironomidæ, Trichoceridæ, Culicidæ, Mycetobiidæ, etc. Both the absence of the independent antennariæ and the great reduction of the membranous areas of the antecoriæ of the present fly are closely related to the modification of the antennæ themselves. In the majority of the cases where the antennariæ are superficially atrophied, the antacoilæ, which properly belong to the antennariæ, are more or less distinctly retained on the membranes of the antennal sockets, and especially often in the Nematocera along the margins of these membranes, ring-shaped sclerites, which are homologous with the antennariæ, are more or less distinctly demarcated from the head capsule, as I have indicated in the case of a certain crane fly. Thus, the antennariæ, although not developed as free independent sclerites, may be more widely present, in the state where they are fused with the adjacent sclerites of the head capsule, among the dipterous insects than Peterson and others suspect. In the present insect also the antennariæ are more probably fused with the common head capsule than completely atrophied.

The sexual variation of the compound eyes is most prevalent among the Nematocera and Brachycera, but in *Nymphomyia* the sexes are very similar in structure, size, and shape. The compound eyes of the Diptera, as a rule, are either separated from each other, the dichoptic type, or two sides of them are contiguous on the dorsal side, the holoptic type, but in *Nymphomyia* the two sides are only contiguous on the ventral side and widely separated on the dorsal side. The extent of the holoptic condition is said by Peterson to depend upon the size of the compound eyes and the location of the antefossæ. In spite of the facts that the antennæ are located close to each other and far remote cephalad from the compound eyes, and that the antefossæ are exceedingly small, the compound eyes in both sexes of this insect are expanded ventromesad and exhibit a unique modification of the holoptic type quite unknown in the Diptera.

The visorlike ridge (Plate 1, fig. 2, *vp*) near and over the bases of the antennæ is quite different in origin from the ptilinum,[7] which is constantly found along the frontal suture of the higher dipterous group Schizophora, since there is no invagina-

[7] In the mature adult stage the ptilinum, as a rule, is completely infolded entad, but very often in certain anthomyiid flies this structure remains external and thickened, forming a crownlike projection.

tion of any kind or endoskeleton associated with it. It is apparently a simple projection of the vertex, which is found in varying degree among the Nematocera; for example, the "frontal tubercle" of the Chironomidæ, the "frontal crest" of the Tipulidæ, etc.

The tentorium undergoes a considerable reduction in the different families, genera, or species and is associated with the reduction of the mouth parts. The complete degeneration of the tentorium occurs on the supratentorium alone, and the other tentoria (anterior and posterior arms) are more or less retained even in the head, which has no functional mouth parts, as seen in *Chironomus*, *Tanytarsus*, and certain other nematocerous flies. In a more reduced or more specialized case the tentorium is not developed as the endoskeleton; in this case it is represented by the external thickening of the gene, as shown by Peterson in the head of *Schizophora*. But in the case of *Nymphomyia* the tentorium has completely disappeared, as in the eucephalous head capsules of the dipterous larvæ greatly differing from the cases mentioned above.

THE THORAX

The peculiar feature of the thorax of this insect is mainly due to the extreme elongation of the cylindrical thorax. The thorax of the nematocerous insects, as a rule, is highly convex in both dorsal and ventral directions, so that the height of the thorax is rather greater than, or at least subequal to, the longitudinal length; and the thorax of the higher dipterous groups, Brachycera and Athericera, is flattened on the dorsum and somewhat angulated along the lateral margins, so that the width of the thorax more or less approaches its length. The thorax of the present insect is very much elongated, being about thrice as long as the greatest width; such extreme elongation of the thorax, so far as I know, is quite new among the dipterous insects, even among the lower groups, such as the Tipuloidea and Psychodoidea. This elongated and cylindrical feature, which is exhibited only in the immature stages in dipterous insects, may be taken as a more primitive character from the evolutional point of view. If so, this species, which in this feature is unique among known Diptera, may represent a very primitive form. Although this unique structure of the thorax reminds one of that of certain immature forms rather than that of the imaginal forms, other morphological features, such as the possession of

the large mesothorax, which occupies the major part of the entire thorax, the extremely developed mesopostscutellum and the highly reduced metathoracic notum, taken in connection with other structures, show that it is unmistakably a dipterous adult in form. Moreover, thoracic characters, such as the fairly well-developed pronotum (*an* and *pn*), although it is small for the extreme development of the mesonotum, and the nonangulated mesopleural suture (p_2) show that this fly belongs to the Orthorrhapha, more particularly to the Nematocera (Plate 2, fig. 5). Finally, the large, isolated, sternal sclerites, taken in connection with their constitution and the small vestigial pleural sclerites, are thought to symbolize a rudimental or primitive condition of their own phylogenetic development among the dipterous insects.

The cervix of the Diptera, as a rule, is very small for the size of the head capsule, while that of *Nymphomyia* is large in comparison with the small head capsule, which is subequal in diameter to the thorax itself. This large diameter of the cervix is distinctly proportional to the large occipital foramen. The pronotum is usually divided transversely by a secondary suture into two parts; namely, the antepronotum and postpronotum, but these parts (at least the antepronotum) are not completely separated longitudinally at the middorsal part. In cases where they are superficially separated into paired lateral portions, the lateral pairs are actually continuous with each other by a very narrow ental chitinization along the cephalic margin of the mesopræscutum, as I have suggested in the case of *Pontomyia*. In the thorax of *Nymphomyia*, on the contrary, both the antepronotum and the postpronotum are completely and widely separated into paired lateral portions by a wide membranous area (Plate 2, fig. 6, *mc*) at the dorsomeson, and the chitinized pronotal bridge is completely lost. Moreover, the paired lateral portions (Plate 2, fig. 5, *pn*) migrate far caudad as if they belonged to the mesopleuron proper. This anomalous position of these sclerites, however, is foreshadowed by the caudal migration of the postpronotum along the lateral margins of the mesonotum, as in the Anisopodidæ, Mycetophilidæ, Blepharoceridæ, Chironomidæ, Culicidæ, etc.

Another peculiar feature of the prothorax is the position of the coxæ. Among the dipterous insects the procoxæ are always articulated ventrally, even in the chironomid midges, where the prolegs are more widely separated from each other than in

other insects. In the present insect they are widely separated and articulated laterally. As a consequence the pleural area (Plate 2, fig. 6, *pp*) is very much reduced between the large notum and the dorsally migrated coxafossa, and is represented only by the procoxacoila. This remaining chitinization is probably derived from the proepisternum alone, completely losing the epimeral chitinization, since among the dipterous insects the undivided condition of the pleuron is never found as well marked as in the other higher orders, and when the reduction occurs on the pleuron the proepisternum remains more stable than the proepimeron. In contrast with the very small pleura, the sternal region (Plate 2, fig. 7, *pst*) is very large, being represented by a large chitinized sclerite. Such a large sternum [8] is never found among the dipterous flies, and, taken in connection with the undivided sternum, which is completely isolated by a membranous area from the adjacent sclerites, reminds one of the primary sternites (Snodgrass) of the Apterygota or the immature forms of the Trichoptera, Odonata, and other orders that have the nymphal or campodeiform early stages.

On the mesonotum of the present insect the scutal suture (suture between the præscutum and the scutum) is completely obsolete, but this is not rare among the Diptera, since it is present only in certain families, such as the Tipulidæ, Trichoceridæ, Tanyderidæ, and Blepharoceridæ, and completely atrophied or greatly reduced in the majority of the Nematocera. The scutopræscutum (præscutum-scutum) and the scutellum are very similar in structure to those of the hypothetical thorax, except for the extraordinary elongation of the former and the distinct flattening of the latter sclerite.

The extraordinary development of the postscutellum (Plate 2, figs. 5 to 7, pl_2) of *Nymphomyia*, which is larger than the preceding notal sclerites (sps_2 and su_2) taken together, represents the most peculiar structure of this thorax. Generally this sclerite is well developed in the lower Orthorrhapha, especially in the Nematocera, but far smaller than half of the scutopræscutum taken alone, even where it is most elongated, as in the Ptychopteridæ. Furthermore, this sclerite is more or less ex-

[8] The broad sternal sclerites are found in the thorax of the Streblidæ and allied families, which are of the most aberrant groups of the Diptera, but in this case the broad sternal condition is evidently derived from the secondary modification of the depression of the dipterous thorax, due to the parasitic adaptation.

tended ventrad or caudoventrad along the precostal margin of the first abdominal segment, hence the thorax, as a whole, appears to be truncated at the caudal end of the scutellum, as distinctly shown in the Cyclorrhapha. This tendency of the postscutellum is already shown in the lower Diptera, being especially pronounced in such nematocerous groups as the Ptychopteridæ (*Ptychoptera* and *Bittacomorpha*), Mycetophilidæ (*Bolitophila*), and Trichoceridæ (*Diazosma*), while in the present insect, contrary to the above general character of the postscutellum, this sclerite (pl_2 and en_2) is extended far caudad, and almost straight, deeply intruding into the first abdominal segment[9] and forming a phragma.[10]

The postscutellum (Plate 2, fig. 5) of this insect is also distinctly divided into paired lateral portions (parascutellæ or pleurotergites, ps_2) and the unpaired median portion (mesascutella or mediotergite, m_2) as in the generalized dipterous thorax. In various nematocerous groups the parascutella is more or less extended ventrad, ending near the base of the haltere or the metaspiracle. Among the Mycetophilidæ this sclerite is more extended ventrad and beyond the metaspiracle. Especially in such mycetophilid gnats as the species of *Mycetophila, Diomonus, Platyura, Asyndulum,* and certain other genera, this sclerite deeply intrudes ventrad or ventrocephalad into the mesoepimeron, and sometimes is almost contiguous with the base of the mesocoxa. As a result of the extreme progression of this tendency, the following unique sclerotization of the present insect is considered mainly to have been derived: The caudal half of the pleural side is almost entirely represented by the broad expansion of the parascutella; the ventral region of the postscutellum is unusually expanded ventrad, forming a broad thickened wall of the sternal side and directly contiguous with the parasternite; the mesonotepimeron is nearly pushed out of its normal position by the cephalic extention of the parascutella; and the mesosternepimeron is widely separated from the mesonotepimeron by the deep cephalic intrusion of the parascutella along the epimeral suture. Another peculiarity derived from this unique parascutella is the relative position of the posterior

[9] A similar feature is shown in certain Hymenoptera, *Pepsis* sp., by Snodgrass (1909).

[10] This phragma is probably derived not only from the mesopostphragma but also from the direct fusion of the narrow metaprephragma with the intruding mesopostscutellum, losing the intersegmental membrane.

two pairs of legs. In all the dipterous insects they are always located close to each other, while in *Nymphomyia* alone the articulations of the meso- and metacoxæ are very widely separated from each other by the broad extension of the ventral region of the parascutellæ.

Thus, in the Nymphomyiidæ we can trace, though with some difficulty, the homologic relation or evolutional line of the postscutellum, but so far as the development of the parascutellæ is concerned, the present insect is so different from all known recent Diptera that their affinity cannot be discussed.

As is generally the case in insects, the Diptera, as a whole, are provided with a well-developed mesopleuron (including the præcoxale), which is clearly divided by the pleural suture into the episternum and epimeron. The episternum is usually subdivided into the notepisternum and the sternepisternum by the episternal suture. The epimeron is also subdivided into the notepimeron and sternepimeron by the epimeral suture. In the present insect the pleuron is vestigial, and its major portion is represented by a uniform membrane, so that these sutures are almost invisible, the pleural suture (Plate 2, figs. 5 and 7, p_2) alone being faintly represented by an incomplete, slightly undulated, creaselike line. In this vestigial and membranous condition the thorax of the present insect differs greatly from that of the Diptera in general, but is rather similar in appearance to that of the Apterygota or the immature forms of other insects. The pleural suture is always distinctly present on the dipterous thorax and serves as an important index in the phylogenetic consideration of the Orthorrhapha as pointed out by Crampton. The nematocerous groups alone have more or less straight pleural sutures, while the brachycerous and athericerous insects have always sharply angulated sutures. The pleural suture of the present insect simulates the condition of the former type, and this fact, even by itself, entitles this insect to a place in the nematocerous group, as I have already suggested in connection with other structures.

The notepisternum becomes more or less membranous in various nematocerous insects and sometimes it is completely reduced into a uniform membrane, which is continuous with the rotaxis as seen in the thorax of *Deuterophlebia* and *Edwardsina*, but this tendency taken alone has no particular phylogenetic significance in the nematocerous group, since such a reduction of the notepisternum occurs sporadically in varying degree

within the same major group or in closely related groups. Contrary to the above feature of the notepisternum, the sternepisternum is always highly developed in the dipterous thorax, and the wide distance between the anterior two pairs of legs is chiefly due to the development of this sclerite. Moreover, among the nematocerous groups the sternal area between the fore and middle legs is often completely or almost entirely represented by the ventrally expanded region of the sternepisternum (formed by the fusion of the episternum proper and the præcoxale) in place of the mesosternum as seen in *Tanytarsus, Chironomus, Microtendipes,* and other midges. In the present insect not only the notepisternum but also the sternepisternum has become membranous, and only the ventral margin of the pleuron is chitinized. Furthermore, the sternepisternum (Plate 2, fig. 7, et_2) is not extended ventromesad, differing in this respect from that of the generalized dipterous thorax, but remains in the proper position as in certain other Panorpoidea (Trichoptera and Lepidoptera), being widely separated from that of the opposite side on the ventromeson by the well-developed mesosternum and its accessory membranous area.

With regard to the epimeron of the present insect (Plate 2, fig. 5), as already suggested, the notepimeron (n_2) and sternepimeron (se_2) are very small and completely separated from each other along the epimeral suture by the deep cephalic intrusion of the parascutella, which reaches the pleural suture. This complete separation of the epimeron (em_2) is also a peculiar character for a dipterous insect since the two subdivisions of the epimeron, however widely they may be separated by the intruding parascutella, are always directly contiguous with each other along the cephalic corner of the parascutella, as in the higher Nematocera (Mycetophilidæ and Bibionidæ) and the lower Brachycera (Leptidæ). The notepimeron of the present insect contracts cephalad and becomes a small sclerite, which appears superficially to be one of the basal wing sclerites. This condition is brought about by the cephalic intrusion of the large parascutella, which has become directly contiguous with the cephaloventral margin of the large pleurotaxis and shifted the postalifera caudad along this margin.

Thus, the great modification and peculiarity of the mesopleural sclerotization of this insect are chiefly due to the extremely anomalous development of the parascutellæ accompanied by the membranation of the pleuron itself.

According to Snodgrass the typical definitive sternum (text fig. 3) consists of the three primary sclerites, presternum (*Ps*), basisternum (*Bs*), and sternellum (*Sl*), and two kinds of the secondary sclerites, spinasternum (*Ss*) and paired laterosternites (*Ls*). These sclerites are often highly variable in form, position, and extent of the development among closely allied groups, and study of their homology is extremely difficult, especially in the highly modified thorax such as of the Diptera. On the mesothorax of the lower nematocerous Diptera, Tipulidæ, Crampton has pointed out the following sternal sclerites: The presternum, basisternum, prefurcasternum, postfurcasternum, and laterosternites. The terminology of these writers differs, but it seems that the presternum of Snodgrass includes both the presternum and the basisternum of Crampton, that the basisternum and the sternellum of the former are homologous with the prefurcasternum and the postfurcasternum of the latter, respectively, and that the spinasternum is quite original with Snodgrass.

In the case of the Nymphomyiidæ the mesosternum consists of two distinct sclerites. The cephalic sclerite (Plate 2, fig. 7, prs_2), the so-called sternannum,[11] is conspicuously separated from the caudal one (Plate 2, fig. 7, *bs* and sm_2), the so-called sternellum, by the membranous transversal area (*ss*), which is provided with a pair of small setæ (these setæ are very difficult to detect on account of their delicate structure). The setigerous nature of this membranous area suggests that it is different in origin from the furcinæ or their derivatives and probably a secondary development, where flexibility is demanded. If so, these sclerites cannot represent the sternannum and sternellum of MacGillivray. The presternum (Snodgrass, text fig. 3, *Ps*), which is clearly shown in the thorax of the Embiidæ (*Cylindrachæta*), is more probably homologous with this cephalic sclerite (Plate 2, fig. 7, prs_2) of the present insect. In the Tipulidæ, the sclerite homologous with the presternum (Snodgrass) consists of the presternum and basisternum (Crampton), but in the present insect such secondary subdivision is found neither externally nor internally on the cephalic sclerite, and it is always represented by one large uniform chitinization. The caudal sclerite of the present insect is provided with a pair

[11] MacGillivray divides the sternum into two sclerites, such as the sternannum and sternellum, according to the position of the furcinæ.

of small sternacoilæ (sc_2) and a V-shaped invagination of the furcæ on its cephalic region. These structures of the caudal sclerite show that it is homologous with the furcasternum (Crampton). The furcasternum or its homologous sclerite, the primary sternum, is subdivided by a thickened transversal invagination (text fig. 3, *fs*) into the pre- and postfurcasternum (Crampton) or the basisternum and sternellum (Snodgrass). This subdivision can be followed in the small V-shaped membranous area and the caudal elongated thickened area of the present thorax. Concerning the origin of the longitudinal ental ridge (usually known as the midventral suture) of the caudal sclerite, two hypotheses may be advanced. This ridge may have been derived from the median spina of the spinasternum through its cephalic extension, or its origin may be traced back to the common invagination (the V-shaped transversal thickening or transternal suture) of the furcæ, which has become extended caudad accompanied by the ental invagination of the sternellum, as in the "Sternagrat" (Weber) of the basisternum of many pterygote insects. The former hypothesis considers the caudal sclerite as a fusion product of the primary sternum and the secondary spinasternum, but this secondary intersegmental sclerite occurs only in the thorax of certain nymphs and of certain lower Orthoptera and is completely wanting in Diptera in general. This longitudinal invagination of the Diptera extends throughout both the meso- and metafurcasternum and is always completely continuous with the common invagination of the furcæ, both externally or in the sutural structure, and internally or in the apodemal structure. Thus, in so far as this longitudinal ridge is concerned, the latter hypothesis, in which the primary sternum is secondarily modified by the development of an apodemal brace derived from the furcæ where rigidity is demanded, seems more natural, and therefore more reasonable than the former hypothesis.

The laterosternites (s. str.), which originate from the subcoxal elements, are found around the coxafossæ in the hypothetical thoracic segment, but in almost all insects, except the Apterygota and nymphal forms, and especially the Diptera, they are firmly fused with the primary sternum, even in the Protonematocera. In the present case the laterosternites are also regarded as completely fusing with the caudal elongated sclerite instead of being completely atrophied, since the trace of the subcoxal elements (special parts of the laterosternites) is

shown as a pair of slender lateral thickenings, the precoxal bridges or præcoxales, which are located cephalad of the coxafossæ and united with the primary sternum proper.

To summarize, this sclerite is considered as consisting of the two divisions of the definitive sternum, namely, the basisternum and sternellum, and the subcoxal elements, namely, the laterosternites and precoxal bridges (text fig. 3).

Besides the sternal sclerites already discussed, there is, on the sternal membrane, closely along the ventral margins of the mesoparascutellæ, a pair of thickened areas that in the present paper are conveniently described as the parasternites (Plate 2, fig. 7, *pt*). The homology and origin of these sclerites is difficult to discern. However, in all probability they were derived either from the secondary chitinization of the sternal membrane or from certain postscutellar sclerites homologous with the katapleurotergites (Young).[12]

The external chitinization of the metanotum is completely wanting or greatly reduced secondarily in the Diptera, although rarely distinct and less modified as in *Psychoda* and the allied genera, and generally it is represented by a very narrow semichitinized band of integument connecting the bases of the hal-

[12] The parascutella (MacGillivray) or pleurotergite (Crampton) is subdivided by Young (1921) into two sclerites: the anapleurotergite and katapleurotergite. Although Young did not discuss the distribution of these sclerites among the Diptera, they are shown by his figures in the following groups of the Orthorrhapha: the Calypterae (excepting the Dexiidae–*Thelaria*) and the Acalypterae (excepting the Micropezidæ–*Calobata*, Piophilidae–*Piophila*, Ephydridæ–*Parydra*, and Oscinidæ–*Chlorops*) and never shown in the lower Diptera such as the Athericera, Brachycera, and Nematocera.

Each lateral portion of the mesascutella is subdivided by MacGillivray (1923) into two sclerites: the parascutella and durascutella. He said that the parascutella sometimes extends onto the pleuron and forms a distinct area, as in the Diptera, between the mesepimeron and the metepimeron, and that the durascutella is the infolded longitudinal thickening on each side separating the mesascutella from a parascutella. From his statement the parascutella may be homologous with the pleurotergite (Crampton) or the ana- and katapleurotergites (Young) taken together. Hence the ana- and katapleurotergites cannot be homologous with the dura- and parascutellæ, respectively. The durascutella of the dipterous thorax has been long neglected by many writers, but I reported the presence of the homologous sclerite on the postscutellum of a certain marine crane fly, *Limonia* sp., in 1930, and I found thereafter wide distribution of this sclerite among various crane flies where it is developed in different degrees.

teres or by an intersegmental membrane between the infolded mesopostscutellum and the precostal thickening of the first abdominal segment. The metanotum of the present insect distinctly belongs to the latter case, losing completely both the external and the internal chitinization, due to the secondary modification (Plate 2, fig. 11).

The metapleuron (Plate 2, fig. 5, et_3 and em_3) is directly adjacent cephalad to the mesoparascutella (ps_2) in the present thorax, due to the extraordinary development of the latter, instead of being adjacent to the mesopleuron as is usual in insects,

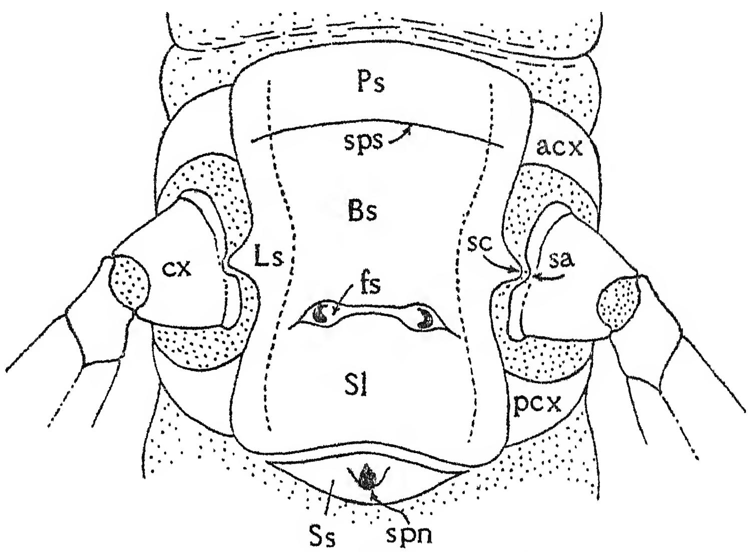

FIG. 3. Hypothetical definitive sternum. (Modified from Snodgrass, 1931.) *acx*, Precoxal bridge; *Bs*, basisternum; *cx*, coxa; *fs*, furcal suture; *Ls*, laterosternite; *pcx*, postcoxal bridge; *Ps*, presternum; *sa*, sternartis; *sc*, sternacoila; *Sl*, sternellum; *spn*, spinafurca; *sps*, secondary presternal suture; *Ss*, spinasternum.

although the position of the metapleuron remains normal. The relative position between the episternum and epimeron of this thoracic segment is almost normal. However, the episternum (et_3) is completely membranous, hence the metapleuron appears to be represented by the undivided pleural sclerite. The epimeron (em_3) is somewhat larger than the membranous episternum. This tendency, although distinctly shown in a rare case (*Dolichopus*), is not usual among the Diptera, where the development of these sclerites in size is reversed.

The metasternum (Plate 2, fig. 7, sm_3) is represented by a large sclerite that is homologous with the caudal elongated sclerite of the mesothorax. Although the shape of this sclerite

is different, the structures are very similar to those of the mesothorax. It differs only in the presence of the postcoxal bridges, which are completely wanting in the mesothorax. The sclerite homologous with the large presternum and the small basisternum of the mesothorax is completely reduced to a uniform membrane in the metathorax, hence a large membranous area persists between the two caudal chitinized sternal sclerites. As stated above, the chitinized metasternite, which is the only chitinized part of the metasternum, is a caudal half of the definitive sternum, and fundamentally different in the morphological significance from the undivided prothoracic sternum (*pst*), since the latter represents the whole of the definitive sternum.

The following is a summary of the principal conclusions derived from the study of the thoracic sclerotization of the Nymphomyiidæ: (*a*) The peculiar general appearance of the thorax is chiefly due to the short but broad membranous condition of the cervix, the extreme elongation of the scutopræscutum and the mesascutella, the loose arrangement of the large sternal sclerites, the rudimental condition of the pleuron and the sternum, and the extreme development of the parascutellæ. (*b*) The sclerotization of the notum coincides well with that of the general dipterous thorax. (*c*) The wide space between the middle and hind legs and the displacement of the mesopleural sclerites are both probably connected directly with the anomalous expansion of the parascutellæ. (*d*) The extreme development of the sternal sclerites is thought to be chiefly due to the rudimental condition of the pleura, and has resulted in the anomalous lateral position of the forelegs. (*e*) The loose arrangement of the sternal sclerites is considered to be due partially to the secondary reduction of the preëxisting sclerites and partially to the rudimentary condition of the adjacent sclerites. (*f*) Although the sternal sclerotization appears to be very primitive, it is not sufficiently primitive to be compared with that of the nymphal forms or lower orders. It probably represents the most primitive condition among the known dipterous insects. (*g*) The nonangulated pleural suture supports the assumption that this insect belongs to the nematocerous Diptera. From the primitive character of the sternal and pleural sclerites this family seems to be placed in a comparatively low phylogenetic position in the Nematocera, but the characteristic modification of the various sclerites suggests that this insect may be far

more advanced than the hypothetical ancestors of Diptera, and represents a specialized family isolated from all other known dipterous groups.

Although in the previous report (1932) the thoracic spiracles were stated to be absent, further study has brought to light very minute, porelike, paired punctures (Plate 4, figs. 11 and 13, *sp*), about 2.5 μ in diameter, situated at the position where the spiracles would be expected. These punctures are very much smaller than the true spiracles of the Psychodidæ and allied insects, which are known to have extremely small thoracic spiracles for the dipterous insects. The external structures, such as the peritreme and related thickenings normally associated with the spiracles, have not been detected in the study of the punctures under consideration, and it is highly questionable whether they are functionally open.

THE WINGS

The shape of the wings is very diverse among the Diptera. Elongation and narrowing frequently occur synchronously with the elongation and narrowing of the body and various appendages, and this relationship is most commonly found in the following Nematocera: The Tipulidæ, Dixidæ, Culicidæ, and Chironomidæ. The higher groups are usually provided with broad wings proportional to the massive body but rarely elongated. Narrow wings are shown in the following slender flies: The Leptogastrinæ and *Dioctria* (Asilidæ), Systropinæ (Bombyliidæ), Xylophaginæ (Leptidæ), *Nerius* and *Calobata* (Micropezidæ), and *Baccha* (Syrphidæ). These features of the wings are derived from the reduction of the caudal area, squama, and alulæ, if present, of the wing membrane. As the result of these reductions the caudoproximal margin of the wing [13] becomes more or less straight and nearly parallel to the anal or cubital vein, as shown in the wings of certain *Systropus* (Bombyliidæ), *Euglochina* (Tipulidæ), and *Stempellina* (Chironomidæ). Also in the Nymphomyiidæ the elongation and the narrowing of the wings well coincide with the above process of the reduction. However, the following features of the wing shape seem to be

[13] In certain Hymenoptera, Homoptera, and Lepidoptera the forewings become very narrow and straight at the caudal margin, losing the large anal lobes. This is due to the development of a special structure that fastens together the two wings on one side for the synchronous wing action. Thus the reduction and narrowing of the forewings of these insects are somewhat different in significance from those of the dipterous wings.

quite characteristic for the present insect; namely, the extreme reduction of the squamal area and the sharply angulated or pointed wing tip, since in those dipterous insects provided with elongated wing the distal area, distad of the cord veins, is usually blunt or round, and the squama remains normal for the family or genus to which they belong.

The long setal fringe of the wings is another characteristic structure of the present insect. The wings of the insects, as a rule, are more or less fringed with hairs, but they are usually inconspicuous and very short in proportion to the size of the wings. The long hairy or scaly fringe is never found irregularly or at random, but its occurrence is limited to the following groups: The order Thysanoptera; certain parasitic Hymenoptera, the Trichogrammidæ and Mymaridæ; small Coleoptera, the Ptiliidæ; and tineinid Lepidoptera, the Gelechiidæ, Cosmopterygidæ, Elachistidæ, Heliodinidæ, Gracilaridæ, Lyonetiidæ, Coleophoridæ, etc. Among the dipterous groups the fringe, although far shorter than in the above insects, is found in the Culicidæ, Psychodidæ, Ceratopogonidæ (*Culicoides, Forcipomyia, Atrichopogon, Lasiohelea,* and *Dasyhelea*), Cecidomyiidæ (*Bryocrypta, Dicroneurus, Holoneurus, Diallactes, Winnertzia,* and *Monodiplosis*), and Chironomidæ (*Zavrelia, Lauterborniella, Polypedilum, Tanytarsus, Stempellina, Metriocnemus,* and *Cardiocladius*). Of the above dipterous groups the development of the wing fringe of the first three families is closely associated with the development of the common setæ or scales of the wing membrane, and no special differentiation, in size or structure, is shown between the setæ on the fringe and those on the membrane. In the last two families, although the fringes are not so conspicuous when compared with the extreme development of the marginal setæ of the present insect, they show more or less special differentiation as an independent structure, the common hairs (both the micro- and macrotrichia) of the membrane being completely or highly reduced, both in structure and in distribution.

In general the long setal fringes are well developed in the wings of minute insects, as mentioned above; the length is usually about or less than 2 to 3 millimeters in dipterous flies; 2 to 3 millimeters in thrips, except certain tubuliferid thrips, which rarely reach 7 millimeters in body length; less than 2 millimeters in chalcid flies, which include probably the smallest hymenopterous insects (0.21 millimeter in body length); and ptiliid or trichopterygid beetles, which contain the smallest known

beetles, ranging down to 0.2 millimeter. Among the Lepidoptera the long fringes are found in forms larger than in other orders, about 8 millimeters or less in body length, but as their designation, Microlepidoptera, signifies, these moths are small compared with lepidopterous insects in general. Furthermore, the setal fringes are the better developed the narrower the wings; they are best exhibited in small tineinid moths. For example, among the Yponomeutidæ, Plutellidæ, Glyphipterygidæ, and Tischeriidæ, species of the narrower-winged genera *Argyrestia, Plutella, Lamprystica, Glyphipteryx*, and *Tischeria* are usually provided with longer fringes than species of the broader-winged genera, *Yponomeuta, Ethmia, Cerostoma, Niphonympha, Imma, Tortyra, Simaethis, Brenthia, Choreutis*, and *Solenobia*. In the fissured wings, like those of the Pterophoridæ and Orneodidæ, the marginal fringes are also highly developed, but in the same family the genus *Ochyrotica*, which has nonfissured massive wings, has shorter wing fringes than the other fissured-winged genera. Among the Diptera this tendency, although not so conspicuous as among the lepidopterous insects, is also exhibited among the Chironomidæ; the wing areas in the genus *Tanytarsus* are reduced in various degrees in different subgenera; for example, species in *Stempellina* and *Zavrella*, which are provided with rather narrow reduced wings that have better-developed marginal setæ than those in other subgenera, such as *Micropsectra, Tanytarsus*, and *Lundströmia*, which are provided with rather broad wings. Moreover, this tendency is shown even among species of the same subgenus; for example, in the subgenera *Stempellina* and *Smitta*, *St. cuneipennis* Edwards, *St. brevis* Edwards, *Sm. angusta* Edwards, etc., which have the characteristic narrow wings, are provided with longer setal fringes than the broad wings of other species of the respective subgenera.

The facts that the long setal fringes are well developed in minute narrow-winged insects, "microes," which are feeble flyers, and that they are never found among large active broad-winged insects, which are swift flyers, suggest that the function of these long fringes is to increase the buoyancy of the insect in the air; that is, to increase the soaring coefficient, as suggested and demonstrated by V. N. Chitrovo (1914) and C. W. Collins (1915) in their studies of plant seeds and the gipsy-moth larvæ, respectively, rather than to increase the efficiency of the wings as propelling organs by compensating for the reduced wing area.

The wing venation of this insect reveals a condition of high specialization, which is in accord with the degree of development of other structural features. Among the Diptera the venation of the Tipuloidea and Psychodoidea represents a primitive stage, while that of the Chironomidæ, Ceratopogonidæ, Simuliidæ, Cyrtidæ, Phoridæ, Hippoboscidæ, etc., is more specialized, in that the cephalization and the thickening of the veins have taken place in varying degrees. The latter group of dipterous insects is generally recognized, as a whole, as more specialized than the protonematocerous group, which is provided with the tipuloid or psychodoid venation. Viewed from this standpoint, the proximocephalic concentration of cephalic veins and the reduction of caudal veins of this insect suggest that the species under consideration is fairly high in the evolutional scale and quite advanced in its own direction of specialization.

The presence of the well-developed ambient vein (veinlike structure of the wing margin) in the wing of this insect is one of the peculiar features common to the Nematocera in general. The ambient vein is considered homologous with the "ring vein" of the Thysanoptera and develops quite often in connection with the wing fringe, compensating possibly for the reduction of wing veins.

The entire proximal group of veins of the present wing ends on the costal margin. Among the dipterous insects the veins that end on the costal margin are either the subcostal or the radial veins or both. The subcosta often becomes very short or even completely atrophied, and more rarely coalesces with the radial vein; if present, it is generally retained as an independent vein. In the present wing the double nature at the proximal part of the costal margin shows that this portion consists of the costa coalesced with the subcosta. This feature of the coalescence is peculiar, not only in the Diptera but also in the other orders, since the subcosta, as mentioned above, usually coalesces with the radial vein instead of the costa, as shown in the forewings of certain Hymenoptera and Homoptera, and in the hind wings of the heteroneurous Lepidoptera in general and certain Neuroptera. The similar or related features are occasionally found in other orders, such as the Jassidæ (*Gypona*) and Psyllidæ (*Psylla*), and also in certain ichneumonoid Hymenoptera, the Ichneumonidæ and the Braconidæ, where the condition of C + Sc + R obtains.

The radial vein is the most stable wing vein and is distinct even in such highly reduced venation as that of the Embioptera (*Oligotoma*), Thysanoptera, Homoptera (both sexes of the Aleurodidæ and males of the Coccidæ), and Diptera (Cecidomyiidæ, Simuliidæ, and Phoridæ). Moreover, the radius of the generalized wing is provided with a definite branch, the radial sector; among the Diptera this sector, although subdivided into from two to four branches, is always more or less angulately branched off from the straight stem from which R_1 extends straight forward. On the basis of these general characters of the radial vein—the characteristic position, its constancy, and the feature of branching—the second cephalic group of veins of the present insect are likely to be homologous with the radial vein and its derivatives.

Of this radial group of the present insect the cephalic straight vein is evidently homologous with the first branch of the radius, but it is questionable whether the caudal branch is homologous with the radial sector itself or with vein R_{4+5}. The two-branched condition of the radial sector is universally found throughout both the orthorrhaphous and cyclorrhaphous groups of the Diptera. These two branches, R_{2+3} and R_{4+5}, are definitely present, however reduced the other veins may be, among members of the higher dipterous groups, but very rarely among the Nematocera R_{2+3} degenerates in situ into a very feeble obscure vein, although not completely obsolete, as shown in the Chironomidæ. However, the simple condition of the radial sector is frequently found among the Orthorrhapha, such as the Ceratopogonidæ, Simuliidæ (excepted *Prosimulium*), Cecidomyiidæ, Mycetophilidæ (Sciarinæ and Mycetophilinæ), and Cyrtidæ. This simple condition is derived from the unbranched Rs or from the distal coalescence of veins R_{2+3} and R_{4+5}. Therefore, the cephalic and caudal veins of the radial group of the Nymphomyiidæ should be designated as R_1 and Rs, respectively. In my previous taxonomic report the latter vein was mentioned as R_{4+5}, R_{2+3} having been considered to be completely atrophied.

The most caudal vein of the present fly may be homologous with either the cubital or the anal vein when considered in connection with its position. However, when the reduction occurs in the anal area of the wing, the anal veins atrophy at first and the cubital veins remain more or less stable, as shown in the wings of certain Termitidæ, Oligotomidæ, Zorotypidæ, Thysanoptera, Aphididæ, and Aleurodidæ. The opposite case is

not definitely known. This tendency is also found in the dipterous groups that have the reduced anal lobes, like certain Systropinæ, or have reduced venation, like the Mycetophilidæ, Cecidomyiidæ, and Cyrtidæ. Moreover, the comparatively broad nature of the present vein, although it is not sharp and strong, is another important character for the suggestion of homology with the cubital vein, since the two cubital veins, Cu_1 and Cu_2, always lie in a close parallel position, apparently forming one broad strong vein in the general dipterous wings. In this sense the most caudal vein of the Nymphomyiidæ may have been derived mainly from the coalescence of the two cubital veins, Cu_1 and Cu_2.

The median veins of wings are the most unstable veins, being frequently reduced or degenerated highly or completely, as we see in the wings of the Embioptera, Thysanoptera, and certain oligoneurous Homoptera and Diptera. This feebleness and the characteristic position between the radius and cubitus suggest

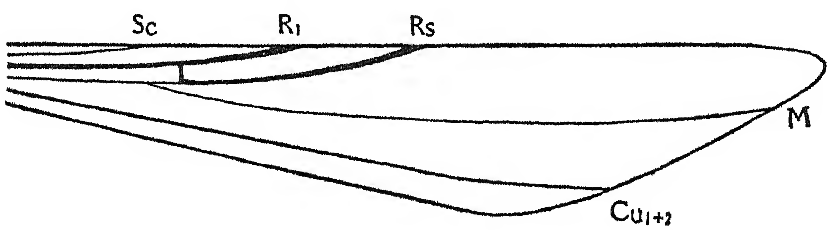

FIG. 4. Hypothetical venation. Sc, Subcosta; R_1, first branch of radius; Rs, radial sector; M, media; Cu, cubitus.

that the creaselike vein of the present insect may be homologous with the vein media, unless it is derived from the folds as in the Blepharoceridæ and Deuterophlebiidæ. Whether this vein represents the unbranched media itself or either vein M_{1+2} or M_{3+4}, is highly problematic, since both conditions are found even in the same dipterous group.

The hypothetical wing venation of the present fly is shown in text fig. 4. It distinctly shows the nematocerous characters in the following points; namely, the median cell and the closed cell Cu_1 are wanting. Among the nematocerous wings there are two types of venation, the protonematocerous and eunematocerous types. In the former type the differentiation of the veins is very poor, and the radius and media are provided with many branches, as in the wings of the Psychodoidea (Tanyderidæ, Ptychopteridæ, and Psychodidæ) and Tipuloidea (Trichoceridæ

and Tipulidæ), while in the latter type the wing venation is more differentiated and the radial and median veins are provided with only a few branches, as shown in the Chironomoidea, Bibionoidea, Mycetophiloidea, etc. In this respect the present venation appears more closely similar to that of the Eunematocera than to that of the Protonematocera. Certain genera of the Cecidomyiidæ, Mycetophilidæ, and Chironomidæ show a reduction of the wing veins similar to that of the Nymphomyiidæ in the simple condition of the radial sector, the median, and the cubital vein.[14]

The wing base is very difficult to study, because the small sclerites are easily shifted from their normal positions and assume very different appearances. This is especially true in the case of minute flies, such as the present species. On the panorpoid wings the basal sclerites are generally well developed and their typical arrangement is well shown on the mecopterous wings. In the Diptera their arrangement and development are more or less modified, but those of the Tipuloidea are almost typical, as shown by Snodgrass (1909), Crampton (1919), and myself (1930). These sclerites of the present insect are greatly reduced, both in size and in number, being correlated with its feeble flying habit. Their arrangement and structure, however, suggest that they still allow the dorsoventral fluttering motion of the wing.

Of these basal sclerites the tegula is usually highly developed in the Diptera, Hymenoptera, Lepidoptera, and Mecoptera, and this sclerite is shown even on the base of the dipterous haltere. In the case of the Nymphomyiidæ it is vestigial and far removed from the tip of the costalis (Plate 4, fig. 13, te_2).

Of the five aliferæ the pleuralifera or the pleural wing process always persists on the thorax of the Pterygota and consists of a prominent pillarlike projection of the pleuron, which is divided into two parts by the pleural suture. But in the dip-

[14] The cubital forks, which are formed by the anastomosis of two adjacent veins, M_{3+4} and Cu_1, usually persist on the wings of the Eunematocera; however, they are frequently reduced into a simple condition of Cu_1 as in the present venation, either by the complete reduction of the cephalic branch, M_{3+4}, as in certain Mycetophilidæ (*Monoclona, Acnemia, Azana, Zygomyia,* and *Sceptonia*) and Cecidomyiidæ (*Holoneura, Miaster, Trisopsis* and *Diallactes*) or by the incomplete anastomosis or by the reduction of the crossvein, m-cu, as in the general Simuliidæ, certain Mycetophilidæ (*Ectrepesthoneura, Plastosciara* and *Sciara*) and Cecidomyidæ (*Winnertzia* and *Clinorhytis*).

terous pterothorax the above original condition of this alifera is more or less modified by a partial reduction of the episternal or epimeral sclerites as well as by the additional development of the secondary sclerite, the subalifera (Crampton). In the case of the simplest modification the pleuralifera is represented only by either the episternal region, losing the caudal half, as in the Dixidæ and Tanyderidæ; or the epimeral region, losing the cephalic half, as in the Blepharoceridæ and Limnobiinæ (Tipulidæ). A higher modification, which is very common among the Nematocera, occurs by the addition of the subalifera in the position of the episternal region of the pleuralifera. In the highest modification the pleuralifera is entirely represented by the subalifera itself, completely losing the epimeral region. In this state the pleuralifera is completely separated from the pleuron and exhibits an independent islandlike structure similar to the other aliferæ freely located on the pleurotaxis, as shown in the Anisopodidæ, Leptidæ, Thaumaleidæ, etc. From the above morphological point of view the independent pleuralifera (Plate 4, fig. 13, *pr*) of the present insect must no doubt be included in the last category.

Of the other aliferæ the most caudal micralifera is always wanting or fused with the postalifera in the higher Pterygota, and it is also wanting in the present insect. The three independent aliferæ (the pre-, med-, and postalifera) are always present in the Pterygota, and the largest of the three is provided with a large ental disc, which serves as an attachment of the wing muscles. This largest alifera is not limited to the specific sclerite, but is represented by either of the above three aliferæ. This ental disc, the pronator disc (Amans), is usually present on the medalifera in the Coleoptera, Lepidoptera, and Hymenoptera, while in the Diptera it is largest on the postalifera, as I have already pointed out in the study of a certain crane fly (1930). Although the medalifera (Plate 4, fig. 13, *ml*) is highly modified into a thin membrane in the present insect, these three aliferæ (*pal*, *ml*, and *pol*) can be distinguished as in the generalized Diptera, but the pronator disc is not developed on any of them. This simple condition of the postalifera also suggests that this fly is not an active flyer.

The pteraliæ are classified into the following groups by MacGillivray (1923): The duritæ, funditæ, and venellæ. The duritæ, which are also known as the axillaries, hypothetically consist of four sclerites, the sigmoidea, submedia, terminalia,

and navicula. In the pterothorax of the Diptera the first sclerite is most strongly developed of the four, being provided with an ental disc to which the wing muscles are attached, and possessing a neck region against which the costalis is directly articulated; while in the present insect these duritæ are obsolete, being represented only by the terminalia (Plate 4, fig. 13, *t*). The costalis is here loosely articulated to the notal wing process (caudalaria?) accompanying a minute obscure sclerite, which may be either the reduced sigmoidea or submedia.

The funditæ, or median plates (Snodgrass), are very unstable sclerites, being easily reduced or united with the venellæ. In certain orders, Orthoptera, Coleoptera, Hemiptera, etc., these sclerites are always present, while in the Lepidoptera and Hymenoptera they are generally obscure or wanting, and when present they are represented by only one sclerite, the mediella, as in the lower Nematocera (*Limonia*). It must be noted here that the term "median ossicles or medipterales" used by Crampton (1919) in the study on the wing-base sclerite of the Panneuroptera (Hymenoptera, Neuroptera, Mecoptera, Diptera, Trichoptera, and Lepidoptera) is somewhat different in meaning from the term "funditæ or median plates," since his "median ossicles" include the various duritæ other than the sigmoidea in addition to the true funditæ.

In the present wing three venellæ (Plate 4, fig. 13), costalis (*cs*), radialis (*ra*), and analis (*as*), are distinctly present as in the generalized wing base, and these structures are highly thickened as compared with the other reduced pteraliæ. Their arrangement and relationship to the wing veins have provided important evidence for the homology of the wing venation.

It is very peculiar that the wings of this fly are deciduous, being easily broken off along a definite line, as is commonly known in the Isoptera and Formicidæ. Whether or not this is a normal occurrence in life is still problematic. The wing is especially thinned between the highly thickened venellæ and the wing stem, showing a suturelike line. When the wings break off along this line, the wing stumps resemble those of ants rather than the scapular shields of termites. Deciduous wings are rare among the Diptera, being known only in *Nymphomyia* and in the female of the parasitic fly *Ascodipteron* (Streblidæ), in which the remaining portion of the wing also consists mainly of the venellæ, as in *Nymphomyia*.

THE LEGS

Delicate and slender legs like those in the present insect are prevalent in the nematocerous group, but the relative length of the three pairs of this fly is not common in dipterous insects. Among the Diptera, as a rule, the hind legs are the longest and the middle shortest. Rarely the forelegs are the longest and the middle shortest, as in the Chironomidæ. In the present fly the forelegs are the longest and the hind shortest. Moreover, the legs usually become elongated, paralleling the slenderness of the abdomen, wings, and various external appendages, as is best exhibited in various families of the Nematocera. In the Nymphomyiidæ the legs are very small for the size of the insect or for its extremely elongated abdomen.

The elongated coxæ and trochanters of *Nymphomyia* are also unusual characters for the Diptera and rarely found in the nematocerous group. The elongation of the coxæ is most distinctly shown in the archaic psychodoid forms, such as *Bruchomyia* and *Nemopalpus*, which probably belong to the oldest existing types of Diptera. The Mycetophilidæ (excepting the Sciarinæ) are also provided with elongated coxæ. This family, although belonging to the eunematocerous group, retains many ancestral or primitive characters in certain structures of the antennæ, the thorax, and, especially, the legs, which suggests that it is intermediate between the other panorpoid groups (Mecoptera, Trichoptera, and Lepidoptera) and the Diptera. The elongation of the coxæ is also found in the forelegs of other archaic Nematocera, the Rhyphidæ (Anisopodidæ or Anisopidæ), which retain many structures related to the older fossil Mecoptera, and it is assumed that the Eunematocera, Brachycera, and other higher Diptera have descended from a common rhyphidlike ancestor. The elongation of the coxæ is usually found in archaic dipterous forms, which suggests the probability that they are more primitive phylogenetically than those that are shorter.[15]

[15] The coxæ often appear superficially to be distinctly elongated in the lateral aspect on account of the following modification: The lateral sides of the coxæ become extended triangularly dorsad (Nematocera) or dorsolaterad (Brachycera and others), whereby the coxacoilæ and artes are found at about the middle in height of the thorax, while the mesal sides remain in the original short condition. Thus this superficial elongation is due to the secondary deformation of the coxæ and need not be discussed here.

Although very rare in the Diptera, the secondary elongation of the coxæ may occur along the line of specialization in connection with the high modification of the other structures of the legs. It is best exhibited in certain remarkable genera of the higher Nematocera, such as *Canthyloscelis* and *Corynoscelis* (both Scatopsidæ) and in the highly specialized grasping legs (forelegs) of the Ephydridæ.

Each coxa of this fly presents a well-marked basal rim set off by a narrow submarginal membranous ring. This basal rim is homologous with the basicoxite of the generalized legs of insects, and the coxal muscles directly start from this rim, not being provided with special apodemal discs (promotors and remotors). The narrow membranous ring is homologous with the basicostal suture (Snodgrass). In the lower primitive orders (Orthopteroidea) this suture internally forms a strong basicosta, while in the higher orders it is very much obscured or entirely wanting. Among the Panorpoidea this suture is usually very much obscured or completely atrophied, although it is always present in Trichoptera, at least on the mesocoxa. In the Diptera this suture is almost always completely wanting. It is very strange that in spite of this the present fly is exceptionally provided with this suture on the coxa of each leg.

The coxa of the pterothorax, as a rule, is subdivided into two parts, the eucoxa (veracoxa or coxa genuina) and meron. In the Panorpoidea generally this feature is distinctly shown in its primitive condition, but only the Diptera show a complex modification on this point. The subdivision of the dipterous coxa very rarely shows the primitive orthopterous type in which the coxal suture or alasuture longitudinally extends throughout the coxa from the trochacoila to the coxartis. This is exhibited by *Pedicia* (Young) and *Limonia* (Tokunaga), in the lowest family, the Tipulidæ. Large members of the nematocerous group show the more or less modified coxal subdivision similar in appearance to that of the Mecoptera, where the coxal suture extends parabolically on one side of the coxa. Thus the proximal margin of the coxa consists of the two sclerites, the eucoxa and meron, but the distal margin is represented by the eucoxa alone. Further along this line of modification, the meron migrates dorsad, intruding onto the pleural region, and at last this sclerite becomes completely fused with the epimeron or sternepimeron, forming the meropleurite or merosternepimeron. Thus the first segment of the leg is represented solely by the eucoxa,

exhibiting an appearance similar to the procoxa, which is not differentiated into the two sclerites. This condition is best exhibited among certain special Nematocera; such as, the Psychodidæ, Blepharoceridæ, Deuterophlebiidæ, Tanyderidæ, and Ptychopteridæ, and the other higher groups, such as the Brachycera [16] and Cyclorrhapha. Often the meron is reduced to a uniform membrane, as in certain chironomid, ceratopogonid, mycetophilid, and cecidomyiid flies. In this reduced state of the meron the coxa appears somewhat similar in structure to the primitive undivided condition as well as in the most highly modified form, since the coxa is represented by one chitinized sclerite, the eucoxa, alone. Of these types of modification the mesocoxæ of the present fly are likely to belong to the last category because of the presence of the large membranous area around the base of the coxa, which may be homologous with the meron, and not due to the undivided nature of the coxæ. Thus the mesocoxæ of this fly must be quite different in constitution from the procoxæ, although they resemble closely in appearance those of the prothorax.

The metacoxa of the Diptera, as a whole, is not subdivided superficially, while in the related orders, Trichoptera, Mecoptera, and Lepidoptera, all the metacoxæ are distinctly subdivided into the two sclerites as well as in the mesocoxæ. Whether the metacoxa here is undivided as in the procoxæ or represented by the eucoxa alone as in the mesocoxa of certain dipterous insects, is quite problematic.

The trochantin is rarely found in the Diptera, and it is commonly said that the legs of Diptera are directly articulated to the thorax without the intermediate sclerites. I have pointed out an exception in the case of the Tipulidæ where this sclerite is present in a highly reduced semichitinous state. In the subject of this paper the sclerite is lacking.

The trochanters of the dipterous legs generally are very short, small, and somewhat triangular in outline, no matter how the legs and coxæ may be elongated, as in the crane flies and fungus gnats. In the present fly all the trochanters are very long and cylindrical. Moreover, each trochanter is firmly fused with the proximal subdivision of the femur along the immovable femasuture. This fused part moves as if it were one segment, being

[16] According to Young (1921) the female of a certain midaid fly, *Midas clavatus*, is exceptional in being provided with the independent meron.

demarked by the trochacoria and the secondary membranous ring of the femur at each end, and is not provided with muscles, which suggests the absence of movement at the femasuture. This immovable trochafemoral union is widely found in various insects, even in the more primitive orders, as in the Thysanura, but it is most prevalent in the higher orders, although in all of these cases the trochanters and femora are fused into one segment, while in *Nymphomyia* the membranous ring of the femur subdivides it into the proximal part, which consists of the trochanter and the proximal end of the femur, and the distal part, which represents the large distal region of the femur.

The dipterous femur usually is simply elongated and somewhat flattened in its cephalocaudal diameter and subdivided femora, like those in *Nymphomyia*, are rarely found among the Diptera. They are only known in the highly specialized parasitic flies, the Nycteribiidæ, and in the Deuterophlebiidæ (female).[17]

On the tibiæ of this fly are also subdivisions similar to those in the femora, and they are equally rare. This pseudosegmental nature of the tibiæ is shown in spider flies as the tibial rings and more definite constrictions are found in many flies and caddice-fly larvæ.[18]

The above discussion on the subdivisions of the femora and tibiæ leads to the conclusion that the pseudosegmental feature in the present insect may result from the mechanical necessity

[17] In the latter case Pulikovsky, Trans. Ent. Soc. London (1924) 45-62, stated, after examining a female adult, which was extracted from the pupal skin, that the trochanter consists of two joints, but I confirmed by observations on females, both the pupal and emerged adult, that the so-called second trochanter is nothing but a part of the femur, which is partially constricted or subdivided on the dorsal side by a semicircular membranous area. At this membrane the leg in the pupal skin is bent sharply as if it were a true segment, but in the fully extended leg of the free-living imago it reveals a structure similar to that of *Nymphomyia*. Thus, unisegmental trochanters are the rule among the Diptera, and the true plurisegmental nature, which is found in certain limited groups (for example, Odonata and Symphyta and certain parasitic Hymenoptera), is never found among the Diptera.

[18] Among the Arachnoidea there is a large segment, the patella, between the femur and tibia, and in a few insects this segment is found as a small intersegmental sclerite, as I have stated in the case of a certain crane fly. Research on the homology between the patella and the proximal subdivision of the tibia and also on that between the second trochanter and the proximal subdivision of the femur, at least in dipterous legs, failed to reveal any relation between the two, respectively.

of providing flexibility to the segment by secondary division or reduction.

The accessory structures of the tarsal claws, such as the pulvilli and empodium, are of considerable importance for classificatory purposes, since they are constantly present in dipterous insects. In the Cyclorrhapha the two padlike pulvilli are always present, although the padlike empodium sometimes is reduced to a bristlelike form. In the Brachycera [19] of the superfamily Eremochæta, as a rule, both the pulvilli and empodium are padlike in structure, while the rest of this series is provided with two padlike pulvilli and one bristlelike empodium. In the Nematocera certain families, such as the Bibionidæ and Rhyphidæ, are usually provided with well-developed pulvilli and empodium similar to the Eremochæta, but in the great majority of this series two pulvilli are completely wanting or vestigial, although a single padlike empodium is retained. Thus, both the absence of the two pulvilli and the presence of the single padlike empodium of the Nymphomyiidæ offer strong evidence that this fly belongs in the series Nematocera.

THE ABDOMEN

The abdominal segments of the insect are divided into three groups; namely, pregenital, genital, and postgenital. The first term is applied to the cephalic seven abdominal segments, which contain most of the visceral organs. The second consists of the eighth and ninth segments, which are highly modified generally on account of the adaptive structures for copulation and oviposition. The last term is used for the segments beyond the ninth, which are greatly reduced and fused with each other.

THE PREGENITAL SEGMENTS

The pregenital segments (common abdominal segments, visceral segments of Snodgrass) of the Diptera are modified and reduced in various degrees according to the taxonomic groups. In the higher groups they are reduced to five or less, while in the nematocerous group there are seven, which are typical and show

[19] Verall, G. H., British Flies. London 5 (1909) 14–47, arranged the brachycerous flies as follows: Eremochæta (Stratiomyiidæ, Acanthomeridæ, Leptidæ, Tabanidæ, Nemestrinidæ, and Cyrtidæ), Tromoptera (Bombyliidæ and Therevidæ), Dermatina (Scenopinidæ and Mydaidæ), Energopoda (Apioceridæ and Asilidæ) Microphona (Empidæ and Dolichopodidæ), Acroptera (Lonchopteridæ), and Hypocera (Phoridæ).

no special differentiation in either sex, as in the species under consideration. In the brachycerous group they show transitional forms between the above two groups, and the number of the nonmodified abdominal segments is variable according to taxonomic division and sex, but tolerably constant within the limits of most of the families. Among the brachycerous insects the hypothetical number of the nonmodified segments is shown in a few families, such as the Leptidæ, Asilidæ, Empidæ, Scenopidæ, and Mydaidæ. In the majority of other families one, two, or more posterior abdominal segments are reduced and modified into the telescopic or concealed genital segments. The significance of the reduction and modification of the abdominal segments is apt to be overlooked, but it must have some phylogenetic importance when taken in connection with the study of the genital segments.

The seven segments of this region as a rule are simple in structure, and in the Nematocera differ but little from one another either in shape or size. The first segment is more subject to modification than is any other. The first segment of the Diptera is somewhat different in size from the adjacent abdominal segment; and, as Young has pointed out, there is a tendency for the first tergum, as well as the corresponding sternum, to decrease in relative size. Usually the first segment is smaller than the second, and this is best exhibited in the higher Diptera. In the lower Diptera, such as the Chironomoidea, Tipuloidea, Psychodoidea, and Culicoidea, the first segment is usually very large but not larger than the second, while in the present fly the first segment, especially its tergum, is unusually large and larger than the second. Moreover, this large segment of *Nymphomyia*, as in the general Orthorrhapha, is never due to the fusion with the second segment, which is quite common throughout the Cyclorrhapha.[20]

[20] There has been reported a secondary suture of the first abdominal tergum named the "adventitious suture" by Young (1921) who stated that this suture "was found in all the species examined among both the Calyptratæ and the Acalyptratæ. Generally speaking this suture is less developed in the calyptrate than in the acalyptrate muscids, etc." But I am not yet certain whether or not the presence or absence of this suture is an important definite mark of distinction between the Cyclorrhapha and the Orthorrhapha, since in certain nematocerous insects, e. g. chironomid flies—similar thickenings are found, although their homology with the adventitious suture remains to be elucidated (Tokunaga, 1932).

In homologizing the sclerites or divisions throughout the abdominal segments, the position of the spiracles is an invaluable guide, but unfortunately in *Nymphomyia* the abdominal spiracles are completely lacking, and the sclerites are also greatly reduced into a common membrane, thus obliterating the usual abdominal divisions. In the case of this fly the lateral groove (text fig. 5, *x–x*) is the only mark by which the divisions of the abdominal segments can be determined. This groove is distinct in the larvæ of holometabolous insects, extending along each side of the body throughout the abdomen and the thorax below the line of the spiracles. It is named the "dorso-pleural" or "tergo-pleural groove" by Snodgrass (1931), the "sterno-pleural suture" by Craighead (1916), the "ventro-lateral suture" by Böving (1914), and the "pleural suture" by Hopkins (1909). As shown by the names applied, the morphologic significance of this groove is differently stated by each of these writers, but I intend to employ the name "tergo-pleural groove" given by Snodgrass, because of the following facts: (*a*) In the thoracic region this groove extends between the paratergite, which is the lateral sclerite of the tergum or the allied region, and the subcoxa, which is homologous with the pleuron; and (*b*) on the genital segments this groove is between the paratergite or allied region and the common limb base of the stylus and gonapophysis, which is also homologous with the thoracic pleuron.

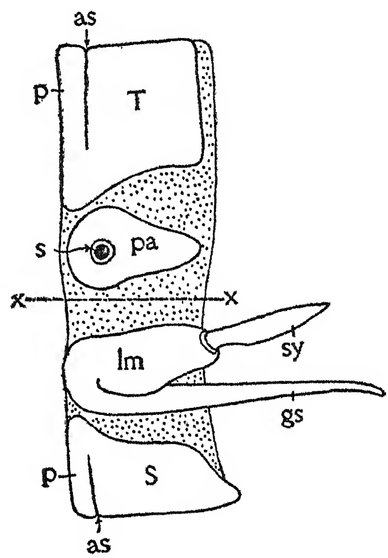

FIG. 5. Diagram of the theoretical abdominal segment. (Modified from Snodgrass, 1931.) *as*, Antecostal suture; *gs*, gonapophysis; *lm*, limb base or pleuron; *p*, precosta; *pa*, paratergite; *S*, sternum; *s*, spiracle; *sy*, stylus; *T*, tergum; *x–x*, tergopleural line.

In the present fly this tergopleural groove (text fig. 2, *Y–Y*) extends longitudinally below the lateral tubercle and the lateral transparent pattern, and is most distinctly shown in the state of contraction of the abdominal muscles. Besides this groove there is another very shallow groove (text fig. 2, *X–X*), which also extends longitudinally above the lateral tubercle or below

the dorsal group of the small tubercles. This shallow groove may be regarded as being derived from the dorsal attachments of the transversal lateral muscles, somewhat similar to the tergopleural groove. For this reason this groove is thought to be homologous with the paratergal suture. Thus we can distinguish in the abdominal segment of this fly the tergum (s. lat.) and the pleurosternum by the tergopleural groove. The tergum is subdivisible into the tergum (s. str.) and the paratergite by the paratergal groove, but the sternum and the pleuron cannot be delimited as they form a completely uniform membrane.

The tergum of *Nymphomyia* is not different in its essential structures from that of insects in general, being provided with the intersegmental membrane, precosta, and antecosta.

The pleurosternal region of this fly also differs but little in the essential structures from that of insects in general. The absence of distinct chitinization and differentiation of precosta and antecosta are the only results of reduction and modification, a condition not very significant since it is very prevalent in the higher orders, not only among the Diptera. Moreover, the distinction between the sclerotization of the pleuron [21] and the sternum (primary sternum) is known in the lower Apterygota and immature forms alone (text fig. 5), whereas in the imagines of the higher Holometabola these two sclerites are completely fused with each other, or the pleuron is completely reduced to a membrane, or both are reduced to a common membrane, as in the present fly. In the latter case, therefore, the so-called "sternum" or "sternite" is either composed of the united pleuron and primary sternum or of the last sclerite alone.

The structure of the paratergal region of this fly is peculiar in the absence of the abdominal spiracle and the presence of the scleritelike tuberculate patch (text fig. 2, *lt*). The non-spiracle or apneustic condition of the dipterous abdomen has been reported by Edwards and Kemper for *Deuterophlebia mirabilis* and *Psychoda phalaenoides*, and this condition is very peculiar for the adult Diptera. The paratergal region of the Diptera generally is completely membranous where the spiracle is found. Sometimes the tergal plate is not divided into the

[21] The pleuron of the abdominal segment is known as the "limb base" in the Apterygota and the campodeiform nymphs, and as the "subcoxa" in certain holometabolous eruciform larvæ (Coleoptera, Hymenoptera, and Lepidoptera).

tergum and paratergite and extends so far downward as to include the spiracles as seen in certain Cyclorrhapha (Tachinidæ, Muscidæ, Sarcophagidæ, Anthomyiidæ, etc.). While in the present form the scleritelike patch is present in the position where the spiracle would be expected. This external differentiation [22] of the paratergal sclerotization is very unusual in the adult Holometabola, since it is found only in the immature forms of certain Coleoptera, Lepidoptera, and Hymenoptera. The origin of this patch, whether it is derived from the preëxistent paratergal sclerite of the larval stage or from the secondary chitinization in the imaginal stage, remains to be investigated.

THE GENITAL AND POSTGENITAL SEGMENTS

In the higher orders of insects, especially the Diptera, the genital and postgenital divisions are very obscure due to the secondary fusion, reduction, and modification for copulation and oviposition. The number of the genital segments is usually considered to be two, but that of the postgenital segments has received diverse interpretations by different authorities. There have been known two representative theories. One is the eleven-segment theory, in which the abdominal segments are counted as nine somites, together with the two postgenital somites, the tenth and eleventh (telson) somites, of which the cerci are the appendages of the tenth abdominal somite. The other is the twelve-segment theory, which is maintained embryologically by Heymons, Wheeler, Nelson, and others, and morphologically by Snodgrass, Imms, MacGillivray, and others, who recognize three postgenital somites, the tenth, eleventh, and twelfth, the cerci properly belonging to the eleventh somite, and the twelfth somite being sometimes known as the telson. On the whole, the balance of opinion inclines towards the latter theory. In the Diptera this primitive theoretical condition is not known to occur, since the posterior-most two, three, or more segments are usually fused with each other and become membranous. In the female of the Tipulidæ, however, the ninth, tenth, and cercus-bearing eleventh, abdominal segments may be distinguished as I reported in 1930, and the females of the Panorpidæ (Mecoptera) show similar abdominal segmentation.

Based on the positions of the genital aperture, anus, parameres, cerci, and cercariæ in the female and of the clasping

[22] Internally the paratergal region is usually characterized in almost all insects by the presence of a special group of the paratergal muscles.

organs in the male, the following segmentation of the terminal region, as illustrated in text fig. 6, may be suggested for the present species.

The anterior genital segment of the female fly differs very much in structure from other Diptera in the presence of the characteristic lateral extension. This lateral extension (Plate 4, figs. 14 to 16; Plate 5, figs. 17 to 19, *pj*) is the specially modified tergopleural fold. Thus, the caudal extensions of this fold have no relation to the true appendages of limb bases, such as the styli and gonapophyses (text fig. 5, *sy* and *gs*), although they superficially assume a position proper for the typical genital appendages. The latter are greatly reduced, as in the general Diptera, and represented only by thickened parameres (text fig. 6, gs_1) guarding the aperture of the gonad in the innermost part of the genital chamber. Among the Diptera the typical gonapophyses and limb bases of the eighth abdominal segment are shown only in the females of the Tipulidæ; in all other Nematocera they are highly reduced, as in *Nymphomyia* or represented by small, paired, membranous lobes, which are known as the octavalvæ (Tokunaga, 1930 and 1932). In the Brachycera and Athericera these structures are completely atrophied. In the Nymphomyiidæ the aperture of the gonad is typically situated between the eighth and ninth sterna, as in the general nematocerous insects, and has not migrated caudad as in the higher groups having telescopic ovipositors. Another modification of the eighth segment is the longitudinal ental thickening of the sternum. This thickening (Plate 4, fig. 16, *ec*) is developed secondarily for the attachment of the muscles related to the female genital organs.

In the male the eighth segment is as peculiar as in the female in the presence of the characteristic paratergal structures (Plate 5, figs. 17 to 19, *pj*), although they are different in shape from the latter. The essential sexual differences are the complete atrophy of the gonapophyses and the related appendages and the absence of both the sternal antecostal thickening and the secondary ental chitinization found in the female. Other fundamental structures of this segment are closely similar to those of the pregenital segment, as in the case of the female.

The ental thickenings of the genital and postgenital segment develop secondarily and sporadically in various regions in widely varying shapes among different groups (families, genera, or species) for mechanical reasons, and between opposite sexes according to the variation of the hypopygial structures. This

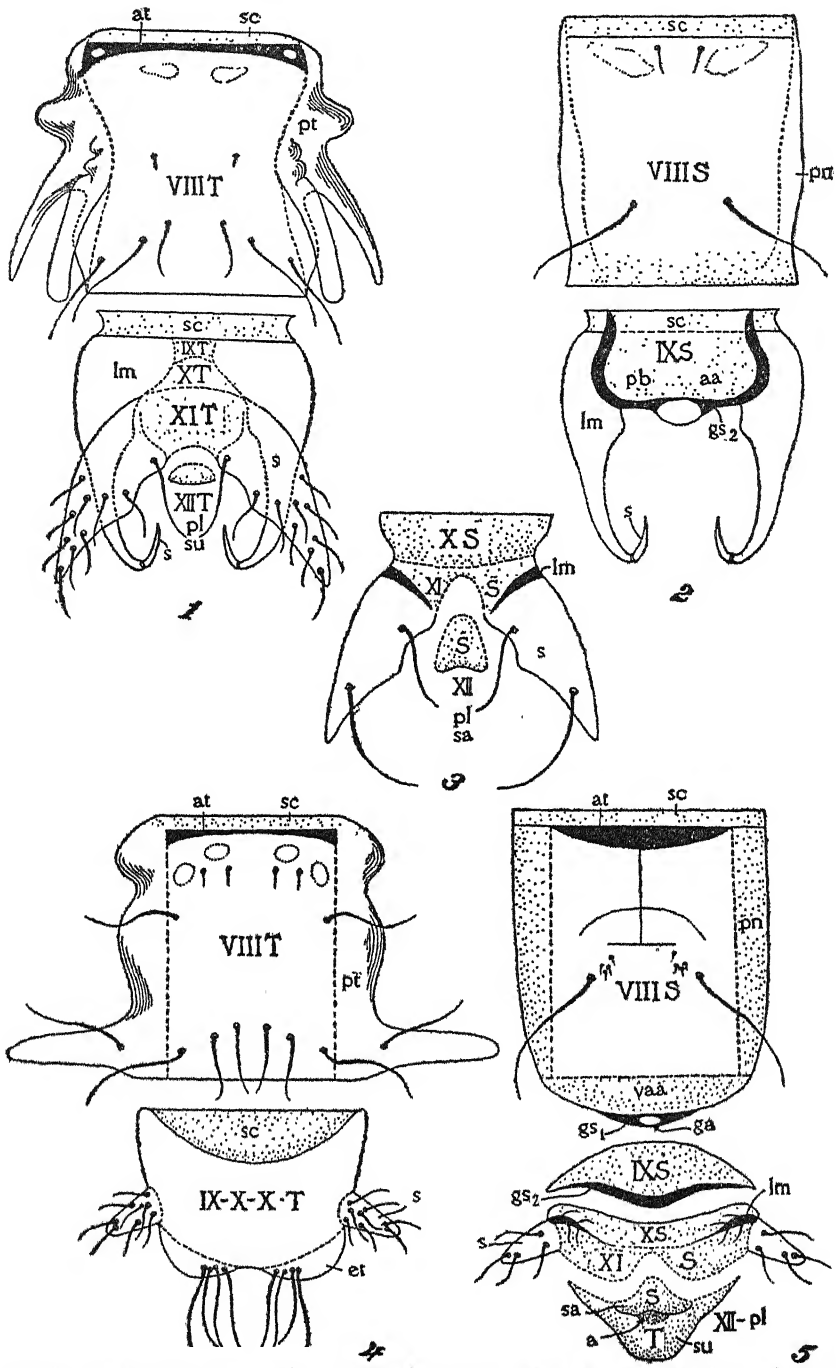

FIG. 6. Diagrams illustrating the concept of the structural plan of the terminal abdominal segments adopted in this paper. *1*, Dorsal aspect, male; *2*, ventral aspect, male; *3*, ventral aspect of the postgenital segments, male; *4*, dorsal aspect, female; *5*, ventral aspect, female. *a*, Anus; *aa*, ædeagus; *at*, antecosta; *ep*, epiproct; *ga*, genital aperture; *gs*, gonapophysis or paramere; *lm*, limb base, coxite or cercaria; *pb*, pons basalis; *pl*, periproct; *pn*, pleuron; *pt*, paratergite; *S*, sternum; *s*, stylus or cercus; *sa*, lami subanalis; *sc*, segmacoria; *su*, lami supra-analis; *t*, tergum; *vaa*, ventral wall of genital chamber.

is best exhibited in the hypopygia of chironomid flies such as *Clunio*, *Tanytarsus*, and *Chironomus*.

In both sexes the paratergal projections are devoid of both the special musculature and the mechanism of articulation, indicating that they are merely a local elongation of the paratergal region and not the regular appendage. In the male sex the paratergal projection is movable dorsoventrad, but this is due to the contraction of the tergosternal muscles, which extend from the common basal plate (paratergite proper) of the projection to the sternum and are not due to the independent movement of the projection by itself.

The eighth segment of the male, as a whole, is not normally provided with genital appendages, no matter how highly it may be modified as in the concealed or retractile genital form of the higher Diptera. The ædeagus (*aa*) is found superficially just caudad of the eighth sternum in this insect, but it properly belongs to the next caudal segment as indicated by a deep membranous furrow formed by the segmacoria between it and the sternum.

In the great majority of dipterous insects, the genital ninth and postgenital somites in both sexes are highly modified from their original features and fused with each other, forming the so-called "terminal ninth abdominal segment." The tenth and twelfth segments, especially, are most unstable and reducible, and it is very difficult to identify them. In this highly modified and reduced condition the important marks are the persistent parameres, cerci, and various clasping organs, which show the location of their own segments. Even when the dorsum is represented by a completely fused sclerotization, they indicate some segmental divisions on the venter.

The dorsum of the terminal segment in the present female is uniformly thickened and there is no trace of segmentation, but the presence of paired cerci, which closely arise from the lateral sides of the dorsum, shows that the eleventh tergum is concerned with the formation of this dorsum. The ninth tergum may be considered either as reduced to a common membrane, forming a large segmacoria, or fused with the posterior terga, forming a common dorsum. In the present fly the latter seems to be the case, since the ninth tergum always remains last when the reduction of these segments occurs, and the eleventh tergum never remains alone without the coexistence

of the chitinization of the ninth tergum. Thus, the dorsum of the terminal segment is regarded as formed by the complete fusion of the ninth, tenth, and eleventh terga.

The venter of the female terminal segment is generally membranous and divisible into two regions by a transversal thickening, which is the second paramere (the first parameres are the paired sclerites of the eighth segment found at the genital aperture at the end of the eighth sternum). Thus, the dorsal wall of the genital chamber, cephalad of the second paramere, is the proper ninth sternum. The caudal region, caudad of this paramere, where the cercariæ, cerci, and blunt paraprocts are found, is formed by the fusion of the tenth and eleventh sterna and periproct. The periproct may be regarded as the remnant of the highly reduced twelfth somite. Thus, the venter of the female terminal segment is divisible into two or three regions; namely, the ninth sternum and the common venter of the postgenital sterna or the twelfth is further separated from the latter.

The terminal segment of the male carries large paired clasping organs, cerci, and unpaired ædeagus. The presence of these structures shows that this segment is formed by the fusion of the ninth and postgenital segments. The dorsum of this segment does not show segmentation, but the lateral sides possess slight constrictions that suggest the demarcation between the clasper-bearing ninth and the cercus-bearing eleventh segments. There can be little doubt, therefore, that the middorsal area is formed by the fusion of the proper ninth, tenth, and eleventh terga. The small area between the bases of the large cerci may be the remnant of the twelfth tergum, known as the lami supra-analis (*su*).

The venter of the male terminal segment is more distinctly divided into two regions than on the dorsum by the presence of the large ædeagus and the distinct cercariæ. The ædeagus is formed by the fusion of the median penis and the paired lateral parameres, which are homologous with the gonapophyses of the ninth segment. Thus, in the present fly it seems to be the caudal projection of the eighth sternum, but it properly belongs to the ninth segment, as already stated. The large pubescent area caudad of the ædeagus, where the cercariæ are located, may be the fused venter of the proper sterna of the tenth and eleventh segments. The most caudal small narrow

area between the bases of the cerci corresponds to the lami supra-analis (*su*) of the periproct (the twelfth somite) and is known as the lami subanalis (*sa*).

Usually the tenth abdominal somite of the Diptera is highly or completely atrophied in both sexes, but its location is frequently shown by the accessory genital apparatus apparently homologous with the gonapophyses and styli of the tenth somite. These apparatus generally are found concealed by the large clasping organs of the male. In certain Rhyphidæ, Culicidæ, Chironomidæ, etc., they are paired and situated close to the bases of the coxites of the clasping organs belonging to the ninth somite. In other families, such as the Blepharoceridæ, Psychodidæ, etc., they become unpaired, median, valvelike projections closely applied on the dorsal side of the ædeagus.

In the great majority of the Diptera the cerci superficially arise from the tenth somite and thereby the cercus-bearing segment is counted as the tenth, but this is due to the reduction of the true tenth somite. The cerci must belong to the eleventh abdominal somite, however, because of the retention of the appendages properly belonging to the tenth somite.

For these reasons, the twelve-segment theory is considered duly applicable to the dipterous abdominal segmentation as well as to that of the generalized insect.

To recapitulate the main points in the homology of the appendages of the terminal abdominal somites of the Nymphomyiidæ, the following may be stated. The lateral projections of the eighth somite in both sexes have no relation to the true pleural appendages, being paratergal in origin. The true appendages of the eighth somite remain as the first parameres in the female, while those of the male are completely atrophied. Those of the ninth somite of the female are also reduced to the second parameres. In the male they are highly developed, the limb bases and styli forming the large paired clasping organs and the gonapophyses taking part in the formation of the large ædeagus. The appendages of the tenth somite are completely atrophied in both sexes. The styli and limb bases of the eleventh somite in both sexes are homologous with the paired cerci and the paired cercariæ, respectively. The twelfth somite of each sex is reduced to the periproct (text fig. 6).

The hypopygial structures show wide divergence among the Diptera, and their phylogenetic affinities are very difficult to ascertain. Taken in connection with other structures, the fol-

lowing features as a whole are considered important in establishing the affinity of this fly to the nematocerous group: The nonmodified pregenital segments, the nontelescopic or nonconcealed hypopygium of each sex, the comparatively simple structures of the male hypopygium, the large elongated cerci of the male located on the caudal end of the abdomen, the large elongated coxites situated laterally, the large exposed ædeagus, the absence of the chitinized ejaculatory filament, and the typical position of the genital apertures in both sexes.

PHYLOGENETIC CONSIDERATION

Although the family Nymphomyiidæ possesses the brachycerous antennæ, it is considered as belonging to the Nematocera, on the strength of the following distinctive characters: Elongated head capsule, large occipital foramen, cylindrically elongated thorax, nonangulated mesopleural suture, nondifferentiated abdominal segments, exposed and comparatively simple structures of the genital segments and their appendages, large and prominent cerci of both sexes, absence of pulvilli, presence of empodium, and the nematocerous wing venation.

This family seems to stand on a comparatively low level in the Nematocera, because of the following thoracic structures:[23] The large pronotum, small pleuron, isolated and large sternum, and elongated coxæ. Other structures, large cerci, large coxites, and styles which are typically arranged, are also thought to be rather primitive characters for the Diptera. This consideration is supported anatomically by the presence of the nonconcentrated independent eight ganglia in the abdomen, as will be reported in a later contribution. However, when the antennal structures, the wing venation, reduced metanotum, fused terminal segments of the abdomen, modified eighth abdominal segment of both sexes, etc., are taken into consideration, this insect is not so low in position as to be compared with the protonematocerous insects or with the archaic ancestral Diptera. The weight of the various extraordinary characters of this insect, then, leads us to the conclusion that this species is a representative of an extremely specialized family isolated from all other groups of the Diptera.

[23] The thoracic sclerotization has a vastly more important significance for the consideration of phylogenetic affinity of the Diptera than other parts and various appendages, because of its comparative stability, as suggested by Crampton (1925 and 1926) and Tokunaga (1932).

SUMMARY

The conclusions derived from morphological study of the sclerotization of the nymphomyiid fly may be itemized as follows:

A. The chief characteristic modification of the head and mouth parts has occurred along the line of reduction of various structures and in the direction of cephalocaudal elongation of the head capsule as a whole.

1. The cephalocaudal arrangement of various organs, such as the antennæ, compound eyes, and ocelli, and also the prognathous type of the head, are intimately related to the elongation of the head capsule.

2. The head capsule consists of the vertex, frontoclypeus, occiput, and probably the antennariæ, stipites, and theca compactly fused together.

3. The occipital foramen is unusually large, which may be due to the prognathous head capsule.

4. The following homology of the peculiar projections of the head capsule may be shown:

Snoutlike projection. Frontoclypeal projection.
Visorlike projection. Cranial projection.
Labiumlike projection. Projection of the theca? or stipes?

5. The following structures of the fixed parts of the head are atrophied:

- Exoskeletons.
  - Labrum-epipharynx.
  - Odontoideæ.
  - Other articular processes.
- Endoskeletons.
  - Corpotentorium.
  - Laminitentorium.
  - Their tentorinæ.
- Sutures.
  - Epicranial.
    - Distal part of the stem.
    - Arms.
  - Occipital.
  - Frontoclypeal, etc.

The proximal part of the epicranial stem alone remains as the middorsal suture on the dorsal part of the head.

6. The great majority of the mouth parts is highly reduced. The pharynx directly opens into the peculiar chitinized pocket-

like mouth concavity. Developmental states of the trophic organs are shown as follows:

- Movable parts.
  - Retained.
    - Paraglossæ? (papilliform projection).
  - Atrophied.
    - Mandibles.
    - Maxillæ and appendages.
    - Labium and appendages.
- Pharynx.
  - Retained.
    - Basipharynx.
    - Postpharynx. Œsophageal pump.
    - Salivary pump.
  - Atrophied.
    - Propharynx.
      - Epipharynx.
      - Tormæ.
      - Epigusta.
    - Parapharynx.
      - Hypopharynx.
      - Oscula.
      - Salivary sclerites.

7. The antennæ are of the brachycerous type and provided with the characteristic intersegmental sensillæ as in the larval antennæ of the Diptera. The constitution of the antenna is shown as follows:

- Articulation.
  - Antennaria (probably fused with the adjacent sclerite of the head capsule).
  - Antacoria (very small).
- Segmentation.
  - Scape (pyriform).
  - Pedicel (spherical).
  - Flagellum (3-segmented).
    - First segment (large and spoon-shaped).
    - Second segment (small and ring-shaped).
    - Intersegmental sensillæ (clavate and three in number).
    - Third segment (small and needle-shaped).

8. The compound eyes are of the holoptic type and characteristic in being contiguous on the ventral side while widely separated from one another on the dorsal side. They consist of the normal oculatæ and biconvex facets.

9. The ocelli are very large, laterally located, and two in number. They may be different in origin from the primitive ocelli

or primary ocelli, but more probably are derived from the lateral ocelli or larval eyespots.

10. The muscles are also reduced, and only twelve different muscles are contained within the head capsule.

B. All the sclerites of the cervix are completely degenerated. The cervix is broad but short and becomes as a whole uniformly membranous.

C. The thorax is highly different from the dipterous thorax in general, both in characteristic modification and in the rudimental condition of its sclerotization.

1. The notum of the prothorax is large and secondarily divided into the antenotum and postnotum, which are completely subdivided into paired lateral halves on the dorsomeson by the cephalic projection of the mesopræscutum and become located on the lateral side.

2. The mesonotum consists of the following sclerites:

- Mesonotum.
  - Scutopræscutum.
  - Scutellum.
    - Scutulis.
    - Parascutules.
  - Postscutellum.
    - Mesascutella.
    - Parascutellæ.
    - Katapleurotergites? (parasternites).

The elongation of the thorax, on the dorsal side, is mainly due to the elongated scutopræscutum and postscutellum (mesascutella). The mesascutella deeply intrudes caudoentad and forms a large phragma, which is one of the two endoskeletons well developed in the thorax. The parascutella occupies almost the caudal half of the entire latus of the thorax, and its anomalous development affects the position of the mesoepimeral sclerites and also the relative position of the middle and hind legs.

3. The sclerites of the metanotum are completely reduced into a uniform membrane, being infolded between the mesothoracic sclerite and the cephalic margin of the first abdominal antecosta.

4. The development of the pleural sclerites is very poor. This may be partially due to the rudimental and membranous condition of the pleuron itself and also to the effect of the intrusion of the parascutella.

5. The pleuron is very small, being represented only by the episternal chitinization from which the procoxacoila is derived. The epimeral sclerites are completely atrophied.

6. The mesopleuron is comparatively small and its chitinization is very low in development. The pleural suture is not sharply angulated but slightly undulated. The episternal suture is obscure. The epimeral suture is completely obliterated by the cephalic intrusion of the parascutella along this suture. The displacement of the epimeral sclerites is chiefly due to the anomalous expansion of the parascutella.

7. The metapleuron is represented only by the epimeral chitinization, completely losing the episternal sclerites.

8. The coxacoilæ of the meso- and metathoracic segments are not developed.

9. The sternal sclerites are fully developed and loosely arranged, as shown in the thorax of certain immature forms or certain lower insects. Viewed from the evolutional standpoint of the thoracic sclerotization of the Diptera, these sternal features, taken in connection with the rudimental condition of the pleuron, indicate that the thorax is in the primitive state of development. The elongation of the thorax, on the ventral side, is mainly related to the large sternal sclerites and their loose arrangement.

10. The constitution of the sternal sclerites is shown as follows:

- Sternum.
  - Prosternum.
    - Undivided primary sternum.
    - Fused laterosternites.
  - Mesosternum.
    - Independent presternum.
    - Membranous basisternum.
    - Elongated sternellum.
    - Fused precoxal bridges.
    - Secondary chitinization? (parasternites).
  - Metasternum.
    - Basisternosternellum.
    - Fused laterosternites.
    - Fused pre- and postcoxal bridges.

Each sternum is provided with a pair of sternacoilæ which are derived from the laterosternites for the articulation of the coxæ. The postcoxal bridges of the mesosternum and the presternum of the metasternum are atrophied. The unusual lateral position of the procoxal articulation is related to the broad prosternum and the vestigial propleuron.

11. The thoracic endoskeletons are generally very low in development. Their relation to the external marks is shown as follows:

Position.	Phragma.	External mark.	Development, etc.
Pronotum	Phragmæ	Phragminæ	Wanting.
Propleuron	Pleuradema	Pleurademina	Obscure, along the pleural suture.
	Entopleuron		Obscure.
Prosternum	Furca	Furcina	Wanting.
	Furcella	Furcellina	Do.
Mesonotum	Prephragma	Prephragmina	Very large, along the cephalic margin of the præscutum.
	Paraphragma	Paraphragmina	Small, along the cephalic margin of the scutulis.
	Lateral phragma		Small, along the laterocaudal margin of the scutulis.
	Postphragma	Postphragmina	Very large, along the caudal margin of the mesascutella, fused with the metaprephragma.
	Caudal phragma		Narrow, along the caudal margin of the parascutella.
Mesopleuron	Pleuradema	Pleurademina	Obscure, along the pleural suture.
Mesosternum	Transversal phragma		Narrow, along the caudal margin of the presternum.
	Furca	Furcina	Small, along the transternal suture.
	Longitudinal phragma		Obscure, along the midventral suture, originated from the furca.
	Furcella	Furcellina	Obscure, along the pleural suture.
Metanotum	Prephragma	Prephragmina	United with the postphragma of the mesothorax.
Metapleuron	Phragma	Phragmina	Wanting.
Metasternum	Furca	Furcina	Obscure, along the cephalic margin of the basisternosternellum.
	Longitudinal phragma		Small, along the midventral suture, originated from the furca.

D. The legs are all slender but small for the size of the insect. The forelegs are the longest and the hind legs are the shortest.

1. The segmentation of the legs is shown as follows:

Morphological segmentation.	Subdivision.	Mechanical segmentation.
Coxa	Coxal rim	First segment.
	Basicostal suture.	
	Coxa proper	
Articulated at the trochacoria between the artes and coilæ.		
Trochanter		Second segment.
Femasuture.		
Femur	Proximal region	
	Membranous ring.	
	Distal region	Third segment.
Articulated at the tibiacoria between the artes and coilæ.		
Tibia	Proximal region	Fourth segment.
	Membranous ring.	
	Distal region	Fifth segment.
Articulated at the tarsacoria between the troclia and flexis.		
Five tarsal segments		Sixth to tenth segments.

2. The coxæ are cylindrically elongated. The mesocoxa consists of the eucoxa alone and the meron is reduced. The coxal rim is not provided with special apodemal discs.

3. Both the trochantin and patella are atrophied.

4. The terminal structures of the leg are as follows:

Retained.
- Claws.
- Calcanea.
- Empodium.
- Tubercula.
- Glenkhöcker.

Atrophied.
- Pulvilli.
- Planta.
- Auxilia.

E. The wings are highly characteristic in form, due mainly to the great reduction of various structures and to the wide modification of the marginal structures.

1. The wings are very narrow and cuneiform, due to the reduction of the alula, squama, and anal lobe.

2. The marginal setæ are extremely developed. They are thought to serve to increase the soaring coefficient of the insect in the air.

3. The well-developed ambient vein is related to the development of the marginal fringe and to the reduction of the true veins.

4. The wings are deciduous along a definite line at the wing basis just distad of the venellæ.

5. The venation is very obscure. The state of development of the veins is shown as follows:

- Retained.
    - Costa and subcosta (coalesced with each other).
    - Radius (2-branched).
        - First radial branch.
        - Radial sector (unbranched).
    - Media (unbranched?).
    - First cubitus and second cubitus (coalesced with each other).
- Atrophied.
    - Anal veins.
    - Secondary veins.

6. The basal sclerites and processes of the wings for the articulation are generally reduced in number and size. The state of their development is shown as follows:

- Aliferæ.
    - Retained.
        - Subalifera (L-shaped and large).
        - Prealifera (small).
        - Medalifera (oval and obscure).
        - Postalifera (oval and large).
    - Atrophied.
        - Pleuralifera proper.
        - Micralifera.
        - Ental discs.
- Pteraliæ.
    - Duritæ.
        - Retained.
            - Sigmoidea? (obscure).
            - Terminalia (small).
            - Submedia? (obscure).
        - Atrophied.
            - Navicula.
            - Ental discs.
    - Funditæ.
        - Atrophied.
            - Costalla.
            - Mediella.
            - Anella.

Pteraliæ—Continued.
  Venellæ.
    Retained.
      Costalis (large).
      Radiales (small).
      Analis (small).
Alariæ.
  Retained.
    Medalaria (minute).
    Caudalaria? (obscure).
    Scutalaria (minute).
  Atrophied.
    Cephalaria.
Other structures.
  Retained.
    Tegula (vestigial).
    Spiralis (comparatively large).
    Ponta (rod-shaped and thickly chitinized).

F. The halteres are normal in structure. The great majority of the basal sclerites and the articular processes are atrophied. The structures retained are the following:

Haltere.
  Scabellum (small).
  Petiole (elongated).
    C+Sc+R (cephalic margin; obscure).
    M+Cu+A (caudal margin; obscure).
  Capitellum (spoon-shaped).
Basal sclerite.
  Tegula (vestigial).

G. The pregenital segments are seven in number, and they are not distinctly differentiated in both sexes, being subequal in shape and structure to each other.

1. The divisions and subdivisions of these segments are as follows:

Pregenital segment.
  Tergum (s. lat.).
    Tergum (s. str.).
    Paratergal groove.
    Paratergite.
  Tergopleural groove.
  Pleurosternum.

2. The abdominal spiracles are all atrophied. The various cuticular structures and their arrangement are shown in text fig. 1.

H. The segmentation of the terminal abdominal region and the relation between it and various appendages and projections are shown in text fig. 5.

1. The constitution and homology of the female genital segments are shown as follows:

- Eighth segment.
  - Tergum.
    - Antecosta.
    - Tergum (s. str.).
    - Paratergite.
      - One projection.
      - Two tubercles.
  - Pleuron.
    - Appendages.
      - Stylus (atrophied).
      - Gonapophysis (first paramere).
    - Limb base (obscure).
  - Sternum.
    - Antecosta.
    - Thickened area (sternum proper).
    - Ental ridge (secondary).
    - Membranous area (ventral wall of the genital chamber).
- Ninth segment.
  - Tergum (fused with that of the postgenital segments).
  - Pleuron.
    - Appendages.
      - Stylus (atrophied).
      - Gonapophysis (second paramere).
    - Limb base (atrophied).
  - Sternum (dorsal wall of the genital chamber).

The genital aperture is found between the eighth and ninth sterna, being guarded by the first parameres.

2. Those of the male genital segments are as follows:

- Eighth segment.
  - Tergum.
    - Antecosta.
    - Tergum (s. str.).
    - Paratergite.
      - Basal plate (paratergite proper).
      - Two projections.
      - Three tubercles.
  - Pleuron.
    - Appendages (atrophied).
    - Limb base (obscure).
  - Sternum (fused with the pleuron forming the pleurosternum).

Ninth segment.
- Tergum (fused with the common terminal tergum).
- Pleuron.
  - Appendages.
    - Stylus (retained).
    - Gonapophysis (paramere of the ædeagus).
  - Limb base (coxite).
- Sternum (pons basalis).

Thus, the ædeagus consists of the parameres, median penis, pons basalis, and ejaculatory duct.

3. The postgenital segments are completely fused in both sexes. Their constitution in the female is as follows:

Tenth segment.
- Tergum (fused with the common terminal tergum).
- Pleuron (obscure).
- Sternum (obscure).

Eleventh segment.
- Tergum (fused with the common terminal tergum).
- Pleuron.
  - Appendages.
    - Stylus (prominent cercus).
    - Gonapophysis (atrophied).
  - Limb base (cercaria).
- Sternum (obscure).

Twelfth segment (periproct).
- Tergum (lami supra-analis).
- Sternum (lami subanalis).

4. The constitution of the postgenital segments in the male is as follows:

Tenth segment (obscure).

Eleventh segment.
- Tergum (obscure).
- Pleuron.
  - Appendages.
    - Stylus (prominent cercus).
    - Gonapophysis (atrophied).
  - Limb base (cercaria).
- Sternum (obscure).

Twelfth segment (periproct).
- Tergum (lami supra-analis).
- Sternum (lami subanalis).

I. The Nymphomyiidæ are considered to be a comparatively low nematocerous family and so specialized as to be quite isolated phylogenetically from all other dipterous groups.

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ILLUSTRATIONS

NYMPHOMYIA ALBA TOKUNAGA

PLATE 1. HEAD AND ANTENNA

FIG. 1. Lateral aspect of head.
2. Dorsal aspect of head.
3. Ventral aspect of head.
4. Dorsal aspect of dextral antenna.

ac, Antacoria.
bx, Basipharynx.
ce, Compound eye.
es, Epicranial stem.
fl, Segment of flagellum.
is, Intersegmental sensilla.
la, Papilliform projection (labium?).
lp, Labiumlike projection.
mc, Mouth cavity.
o, Occipital margin.
oc, Ocellus.
of, Occipital foramen.
ol, Oculata.
op, Œsophageal pump.
p, Pedicel.
sn, Snoutlike projection.
sp, Scape.
t, Toothlike projection.
vr, Visorlike projection.
vt, Vertex.

PLATE 2. THORAX

FIG. 5. Lateral aspect.
6. Dorsal aspect.
7. Ventral aspect.

ad, Abdominal segment.
an, Antepronotum.
bs, Basisternum.
c, Coxafossa.
cc, Cervix or cervacoria.
co, Coxacoila.
em, Epimeron.
en, Ental invagination or caudal phragma.
et, Episternum.
h, Haltere.
la, Lateral phragma of scutellum.
m, Mesascutella.
ma, Medalaria.
mc, Mesocoria.
md, Middorsal suture.
ms, Midventral suture.
n, Notepimeron.
p, Pleural suture.
pa, Paraphragma.
pc, Parascutulis.
pl, Postscutellum.
pn, Postpronotum.
pp, Propleuron.
prs, Presternum.
ps, Parascutella.
pst, Prosternum.
pt, Parasternite.
pv, Pseudosutural fovea.
r, Rotaxis.
s, Scutalaria.
sa, Supra-alar seta.
sc, Sternacoila.
se, Sternepimeron.
si, Scutulis.
sl, Spiralis.
sm, Sternellum.
sps, Scutopræscutum.
ss, Secondary (transsternal) suture.
st, Transversal stripe.
su, Scutellum.
ws, Wing base.

PLATE 3. LEGS AND HALTERE

FIG. 8. Foreleg.
9. Middle leg.
10. Hind leg.

c, Claw.
cn, Calcanea.
cx, Coxa.
d, Distal subdivision.
e, Empodium.
f, Femur.
fs, Femasuture.
gh, Glenkhöcker.
mc, Basicostal suture of coxa.
mf, Membranous ring of femur.
mt, Membranous ring of tibia.
p, Proximal subdivision.
sn, Sensilla.
t, Trochanter.
ta, Trochartis.
tb, Tibia.
tba, Tibiartis.
tbc, Tibiacoila.
tc, Trochacoila.
to, Trochacoria.
tp, Tarsal spine.
ts, Tarsal segment.
tu, Tubercula.

11. Sinistral haltere, lateral aspect.

bsr, Basal swelling of rotaxis.
ca, Capitellum.
em, Epimeron.
et, Episternum.
in, Invagination between thorax and abdomen.
m, Mesascutella.
ps, Parascutella.
ptl, Petiole.
r, Rotaxis.
sad, Sternal side of abdomen.
sc, Scabellum.
sp, Porelike puncture (spiracle?).
tad, Tergal side of abdomen.
te, Tegula.

PLATE 4. WING AND TERMINAL SEGMENTS OF FEMALE

FIG. 12. Wing.

am, Anal margin.
av, Ambient vein.
C, Costa.
cm, Costal margin.
Cu, Cubitus.
M, Media.
om, Outer margin.
ps, Placoid sensilla.
R, Radius.
Rs, Radial sector.
Sc, Subcosta.

13. Wing base, ventrolateral aspect.

as, Analis.
cs, Costalis.
ma, Medalaria.
ml, Medalifera.
n, Notepimeron.
np, Notepisternum.
p, Pleural suture.
pal, Prealifera.
po, Ponta.
pol, Postalifera.
pr, Subalifera (pleuralifera).
ps, Parascutella.
r, Rotaxis.
ra, Radialis.
sa, Supra-alar seta.
se, Sternepimeron.
sl, Spiralis.
sp, Porelike puncture (spiracle?).
su, Scutellum.
t, Terminalia.
te, Tegula.
ws, Wing base.

14. Terminal segments of female, dorsal aspect.
15. Terminal segments of female, lateral aspect.
16. Terminal segments of female, ventral aspect.

a, Anus.
at, Antecosta.
cc, Cercaria.
ce, Cercus.
ec, Ental thickening.
ep, Epiproct.
gc, Genital chamber.
os, Octasternum.
ot, Octatergum.
pj, Paratergal projection.
pp, Paraproct.
pt, Paratergite.
sa, Lami subanalis.
sc, Segmacoria.
su, Lami supra-analis.
t, Tubercle.

PLATE 5. TERMINAL SEGMENTS OF MALE

FIG. 17. Lateral aspect.
18. Dorsal aspect.
19. Ventral aspect.

a, Anus.
aa, Ædeagus.
at, Antecosta.
cc, Cercaria.
ce, Cercus.
cx, Coxite.
h, Harpe.
if, Intersegmental furrow.
os, Octasternum.
ot, Octatergum.
p, Penis.
pa, Paramere.
pb, Ponta basalis.
pj, Paratergal projection.
pp, Paraproct.
pt, Paratergite.
s, Style.
sa, Lami subanalis.
sc, Segmacoria.
su, Lami supra-analis.
t, Tubercle.
te, Telson.

TEXT FIGURES

FIG. 1. Head of *Nymphomyia alba* Tokunaga. Cross sections of the basipharynx; *a*, through the attachments of the anterior dilators; *b*, through those of the posterior dilators; and, *c*, of the posterior region before the œsophagus.

bx, Basipharynx.
cn, Connective nerve.
fg, Frontal ganglion.
oe, Œsophagus.
ol, Oculata.
op, Œsophageal pump.
p, Pedicel.
sbg, Subœsophageal ganglion.
sd, Salivary duct.
sg, Salivary gland.
slp, Salivary pump.
sp, Scape.
spg, Supraœsophageal ganglion.

2. Diagrammatic arrangement of the cuticular structures of the abdominal segment.

ac, Antecosta.
lt, Lateral tubercle.
tb, Tubercule.
tp, Transparent pattern.
X–X, Tergoparatergal line.
Y–Y, Tergopleural line.

3. Hypothetical definitive sternum. (Modified from Snodgrass, 1931.)

acx, Precoxal bridge.
Bs, Basisternum.
cx, Coxa.
fs, Furcal suture.
Ls, Laterosternite.
pcx, Postcoxal bridge.
Ps, Presternum.
sa, Sternartis.
sc, Sternacoila.
Sl, Sternellum.
spn, Spinafurca.
sps, Secondary presternal suture.
Ss, Spinasternum.

4. Hypothetical venation.

Sc, Subcosta.
R_1, First branch of radius.
Rs, Radial sector.
M, Media.
Cu, Cubitus.

5. Diagram of the theoretical abdominal segment. (Modified from Snodgrass, 1931.)

as, Antecostal suture.
gs, Gonapophysis.
lm, Limb base or pleuron.
p, Precosta.
pa, Paratergite.
S, Sternum.
s, Spiracle.
sy, Stylus.
T, Tergum.
x–x, Tergopleural line.

6. Diagrams illustrating the concept of the structural plan of the terminal abdominal segments adopted in this paper, *1*, dorsal aspect, male; *2*, ventral aspect, male; *3*, ventral aspect of the postgenital segments, male; *4*, dorsal aspect, female; *5*, ventral aspect, female.

a, Anus.
aa, Ædeagus.
at, Antecosta.
ep, Epiproct.
ga, Genital aperture.
gs, Gonapophysis, or paramere.
lm, Limb base, coxite, or cercaria.
pb, Pons basalis.
pl, Periproct.
pn, Pleuron.
pt, Paratergite.
S, Sternum.
s, Stylus, or cercus.
sa, Lami subanalis.
sc, Segmacoria.
su, Lami supra-analis.
T, Tergum.
vaa, Ventral wall of genital chamber.

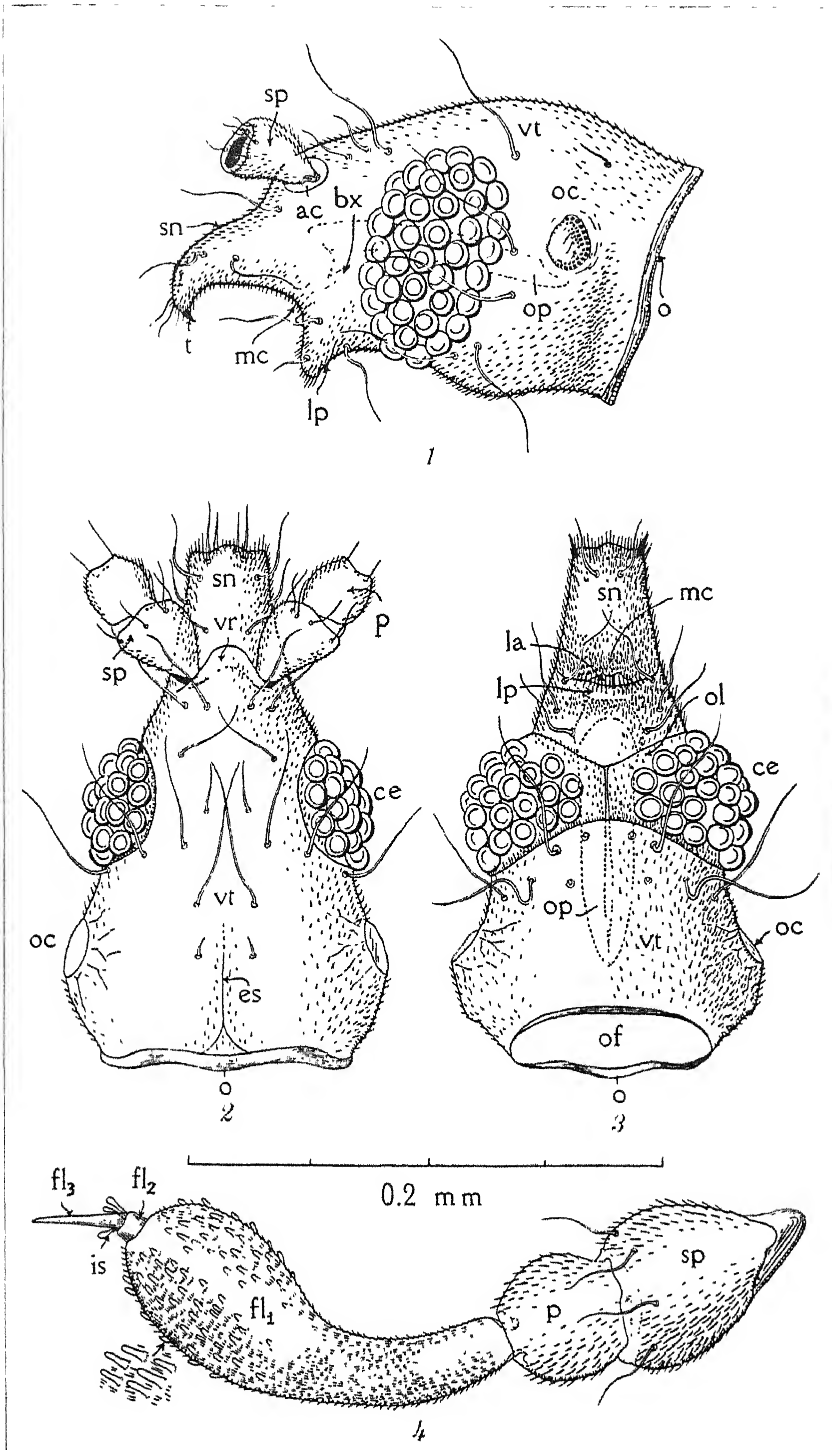
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PLATE 1.

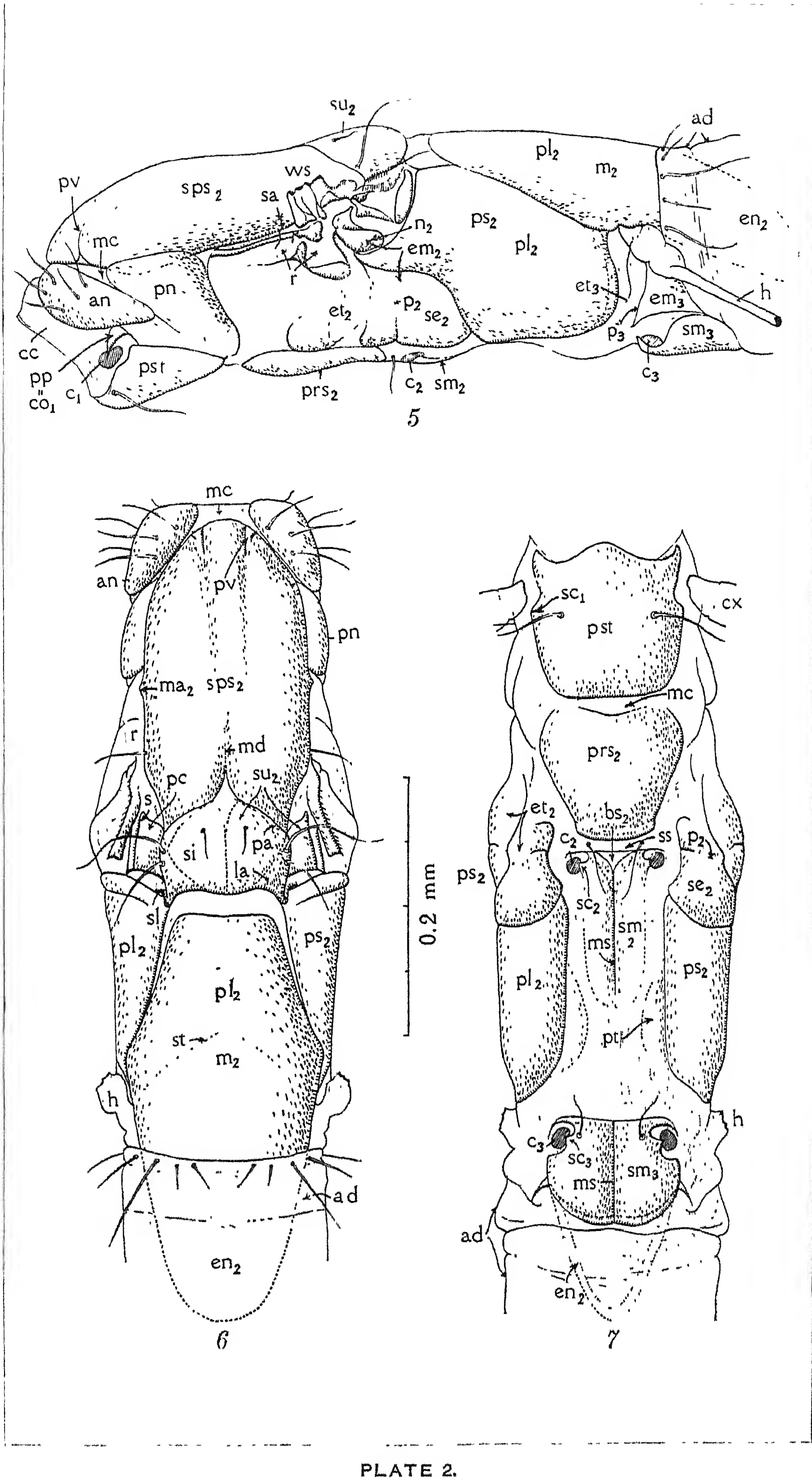

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PLATE 2.

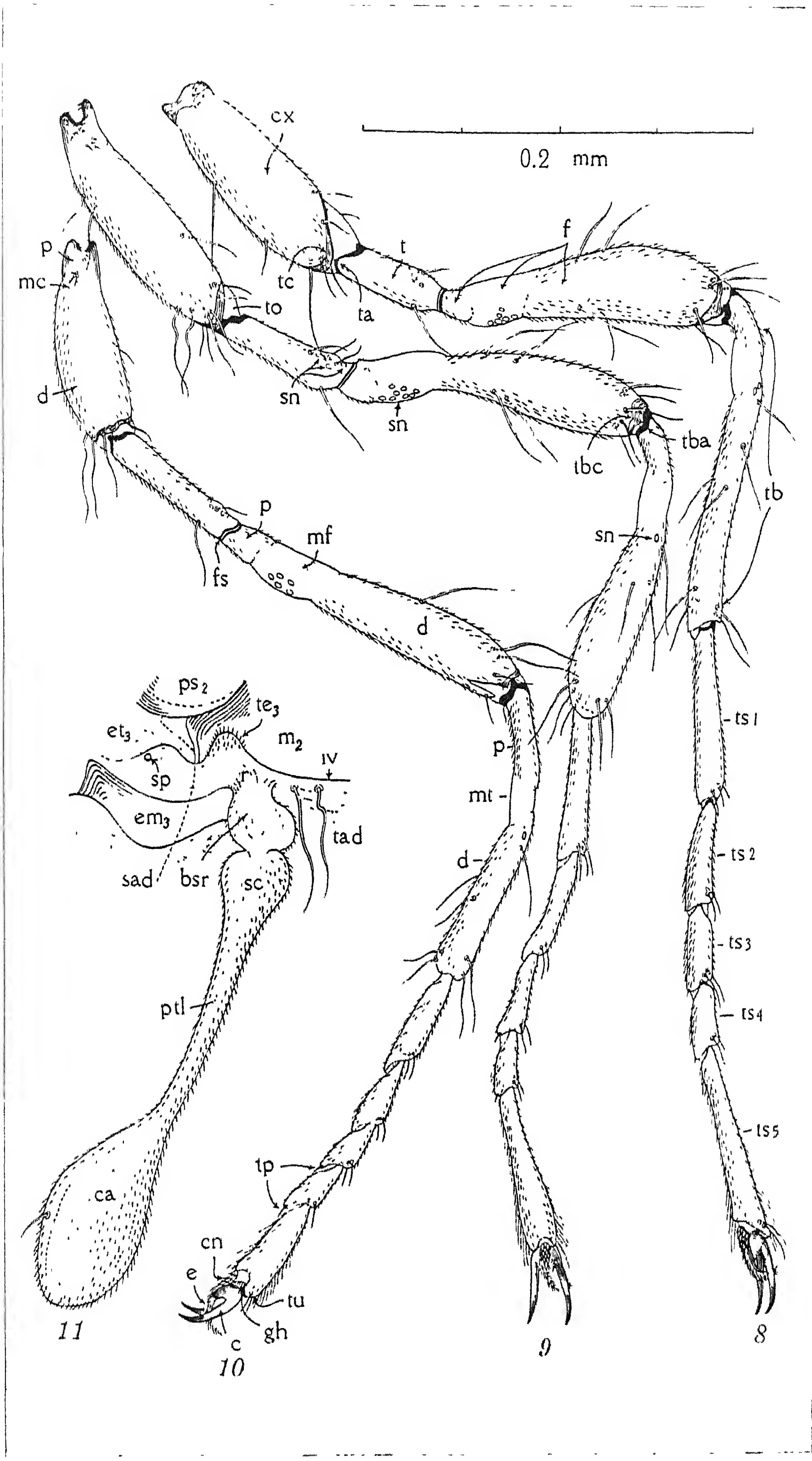

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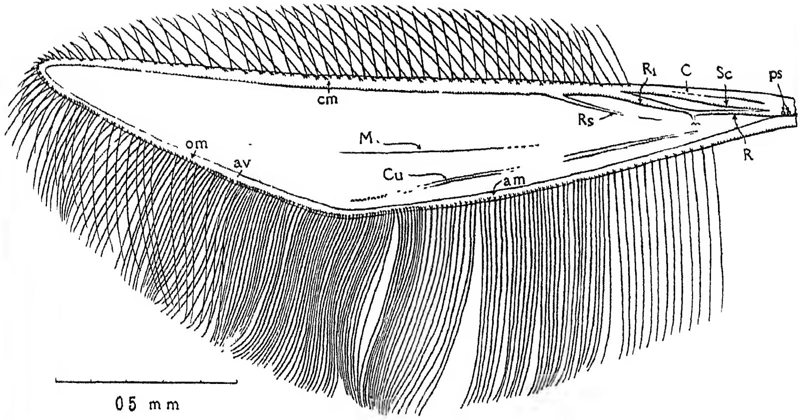
PLATE 3.



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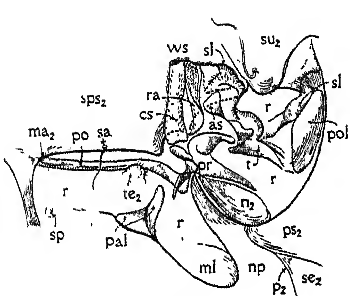

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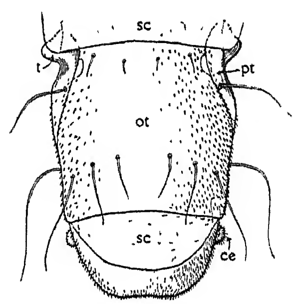

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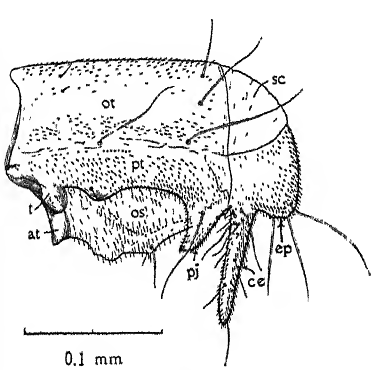

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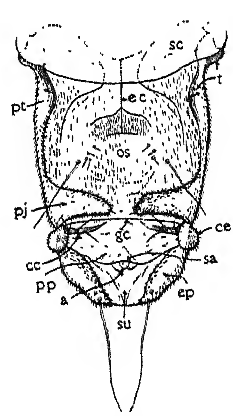

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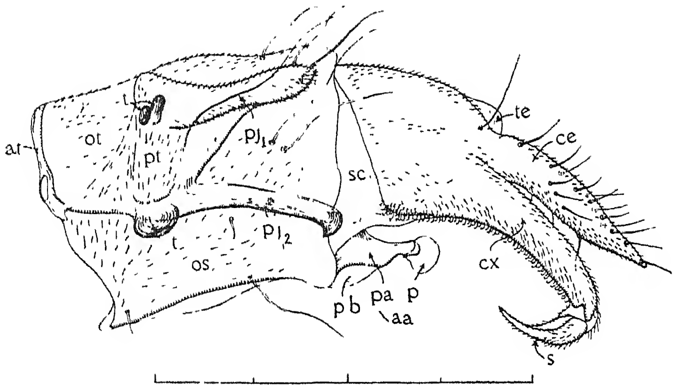
PLATE 4.



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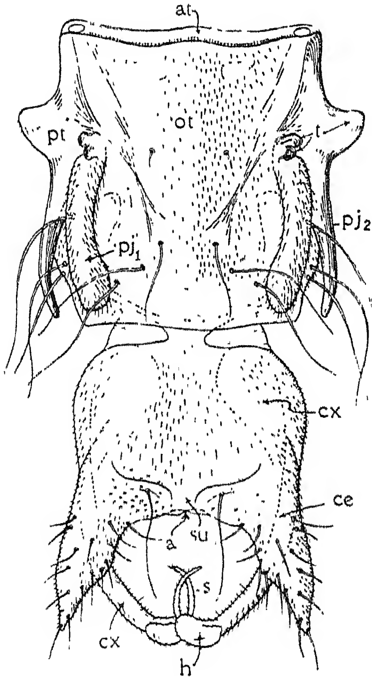

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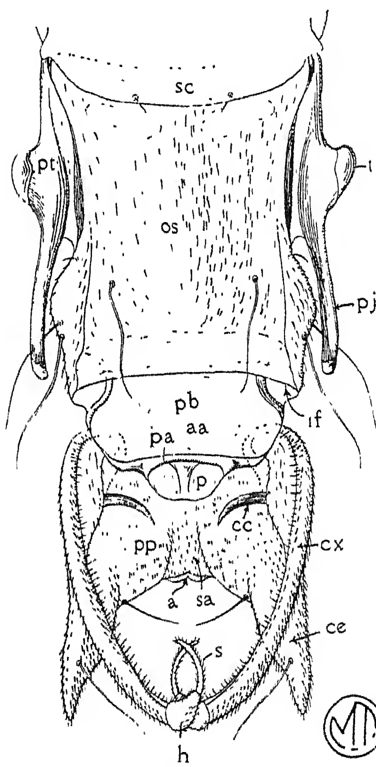

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PLATE 5.

PHILIPPINE PARAPERCIDÆ

By Claro Martin and Heraclio R. Montalban
Of the Fish and Game Administration, Bureau of Science, Manila

THREE PLATES

The present paper contains a review of the species of the family Parapercidæ known to inhabit Philippine waters. It is based on specimens in the collection of the Fish and Game Administration, Bureau of Science.

PARAPERCIDÆ

Body elongate, sybcylindrical, posteriorly compressed, covered with small ctenoid scales; head a little depressed; eyes more or less lateral, close together; mouth moderate or denticulate; interopercle usually not entire; opercle with a spine; subopercle either blunt or pointed; gill membranes united, free from isthmus; branchiostegals 6; pseudobranchiæ present; dorsal fin long, usually continuous; anal similar to soft dorsal; ventrals thoracic, I–5; air bladder absent; pyloric cæca few.

Small fishes found in reefs and along shores, sometimes in deeper waters, from the Red Sea and the east coast of Africa through the seas of India to Polynesia.

According to the scheme of classification of Jordan the Parapercidæ are closely related to the Mugiloididæ on one side and to the Pteropsaridæ on the other. Species of these two families have so far been neither collected nor reported from the Philippines.

Genus PARAPERCIS Bleeker

Parapercis Bleeker, Ned. Tijdschr. Dierk. 1 (1863) 236.

Body cylindrical, rather elongate; cleft of mouth oblique; teeth in villiform bands with small curved canines; no teeth on palatines; teeth on vomer; dorsal divided, spinous portion with four or five spines.

Key to the Philippine species of Parapercis Bleeker.

a^1. Spinous dorsal with five spines.
 b^1. Caudal with black dots; no caudal blotch.

c^1. Suprascapular region without a blotch.
Parapercis cylindrica (Bloch).

c^2. Suprascapular region with a white-and-black-ringed brown spot.
Parapercis tetracantha (Lacépède).

b^2. Caudal blotch present.

c^1. Blotch on caudal large, black; sides of body with three to seven ocelli........ *Parapercis hexophthalma* (Cuvier and Valenciennes).

c^2. Blotch on caudal white; cheeks with oblique, narrow bands.
Parapercis dorsonebulosa sp. nov.

a^2. Spinous dorsal with four spines.

b^1. Suprascapular region with a white-edged ocellus, head with black dots .... *Parapercis clathrata* Ogilby.

b^2. Suprascapular region not ocellated; head with brown blotches.
Parapercis montillai sp. nov.

PARAPERCIS CYLINDRICA (Bloch). Plate 1, fig. 1.

Sciæna cylindrica BLOCH, Ausl. Fische 6 (1792) 42, pl. 299, fig. 1.

Percis cylindrica CUVIER and VALENCIENNES, Hist. Nat. Poiss. 4°. 3 (1829) 199; BLEEKER, Nat. Tijdschr. Ned. Ind. 2 (1863) 235; GÜNTHER, Cat. Brit. Mus. 2 (1860) 239.

Parapercis cylindrica JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 [(1907) 1908] 281; WEBER, Siboga Exp., Fische (1913) 519; FOWLER, Mem. P. Bishop Mus. 10 (1928) 424.

Dorsal V, 21; anal 18 or 19; scales on lateral line 49 or 50; between lateral line and origin of dorsal 4; between lateral line and origin of anal 17 or 18.

Body elongate, moderately compressed, its depth 4 to 4.6 in length; depth of caudal peduncle 2.5 to 3 in head; dorsal profile almost as strongly arched as ventral outline, but a little more curved; head small, pointed, 3.4 to 3.7 in length; snout acutely rounded at tip, 2.5 to 3.3 in head; eye small, moderately high, almost equidistant from tip and edge of opercle, 3.4 to 3.9; interorbital flat, wide, 8.8 to 11.4; mouth small, oblique; lips not broad; premaxillaries not very protractile; maxillary almost entirely concealed by preorbital, extending to, or a little behind, anterior border of eye; upper jaw with an outer series of enlarged teeth which are coarser in front, with one short curved canine on each side and a band of villiform teeth inside; lower jaw with an outer series of coarse teeth in front, with a long canine on each side at the termination of the series, and an inner villiform band in front, continuing posteriorly to a single series of enlarged ones; villiform teeth on vomer. A spine at upper angle of opercle; interopercle and subopercle terminate in a spine; that of former sometimes blunt.

A rather deep notch between the spinous and soft dorsals; third and fourth spines longest, as long as snout; or slightly

longer; anterior dorsal rays as long as distance from tip of snout to hind margin of pupil; anal inserted below fifth dorsal ray; pectoral small, rounded, 4.5 to 4.9; ventral slender, reaching as far as sixth anal ray, 3.1 to 3.7; caudal rounded or slightly so, with upper lobe pointed but very slightly produced.

Ground color in alcohol grayish white to yellowish, nine brownish to blackish vertical bands on each side of body, the middle ones spindle-shaped; a short dark-edged band on snout from its tip to eye where it joins another one crossing middle of eye longitudinally or slightly obliquely; top of head with a coarse network of very pale blue, inclosing brownish spaces; a vertical brown band from lower part of eye across cheek; a narrower band of same color running obliquely across jugular region, meeting its kind ventrally; a blackish blotch with a narrow strip of white above at basal half of spinous dorsal; pectoral and ventral, respectively, yellowish brown and brownish gray in life; soft dorsal with yellow edge and basal black spots; dusky areas at anterior portion gradually become defined as small spots posteriorly; anal with many small dusky spots sometimes fused to form vertical bands; caudal brownish in life, spotted with dark blackish brown, larger at base, with white edge and with a submarginal dusky border.

This species is seemingly the commonest of the family. It is represented in the collection by specimens ranging in length from 48.5 to 135 millimeters collected from different localities from Polillo southward to Sitankai.

PARAPERCIS TETRACANTHA (Lacépède). Plate 1, fig. 2.

Labrus tetracanthus LACÉPÈDE, Hist. Nat. Poiss. 4°. 3 (1802) 428, 473, [not *Percis tetracanthus* BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 458, which is *P. quadrispinosus* (Weber)].

Percis cancellata CUVIER and VALENCIENNES, Hist. Nat. Poiss. 4°. 3 (1829) 200; BLEEKER, Nat. Tijdschr. Ned. Ind. 9 (1855) 501; GÜNTHER, Cat. Brit. Mus. 2 (1860) 240.

Parapercis tetracanthus JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 [(1907) 1908] 281; WEBER, Siboga Exp., Fische 65 (1913) 518.

Parapercis tetracantha OGILBY, Proc. Roy. Soc. Queensl. 23 (1910) 40. Not described.

Dorsal V, 21; anal 18; scales on lateral line 59 to 60; between lateral line and origin of dorsal 8; between lateral line and origin of anal 19 to 22.

Body elongate, rather cylindrical, its depth 5.9 to 6.2 in length; caudal peduncle compressed, its depth 3 to 3.3 in length of head;

dorsal outline of head and body slightly more arched than ventral; head rather depressed with moderately bulging cheeks, 3.3 to 3.5 in length, snout regular, 2.8 to 3 in head; eye large, much advanced forward, its upper margin slightly projecting above head, 4.6 to 4.9; interorbital narrow, 9.2 to 11; mouth moderately large, oblique; lips broad; lower jaw projecting; premaxillaries protractile; posterior portion of maxillary partly exposed, extending a little beyond anterior border of eye; upper jaw with an outer series of coarse teeth with several long ones in front and on the sides, and an inner villiform band narrowing posteriorly; lower jaw with an outer series of coarse enlarged teeth, four in front and three at each side directed posteriorly, and an inner villiform band not continuous behind; teeth also on vomer; preopercle entire; a strong, rather flat spine on upper angle of opercle.

Membrane uniting spinous and soft dorsals low; third and fourth spine longest, as long as eye or about equal to it; anterior dorsal rays as long as distance from snout to about middle of pupil and inserted below fifth dorsal ray; pectoral short, broadly rounded, its length 5.4 to 5.7 in body; ventral pointed, 4.4 to 5.2; caudal rounded, with projecting upper and lower lobes, the former a little longer than the latter, its length 5.2 to 5.7.

Scales behind occiput, on cheeks, breast, and abdomen smooth; finely ctenoid all over the rest of body and base and upper and lower lobes of caudal; snout, sides of head, and occiput naked.

Color in alcohol dark brown, lighter below on each side; three series of light blotches with slightly darker centers; eight blotches along each side of back, comprising the first series, each continuous with the corresponding blotch on the other side; second series along middle of body consists of nine alternating with those above, the third corresponding with the second, each with white edge, narrow above and wider below across the belly, and continuing with that of the other side; a black dot on each side of tip of snout; a long blackish blotch on each side of upper lip; lower lip and chin brown; a broad brown blotch on cheeks below eyes; a large white-and-black-ringed brown spot on suprascapular region; a black vertical blotch below base of pectoral; two pairs of small black blotches on belly, sometimes connected; a larger black blotch below base of pectoral; membranous portion of first dorsal whitish with some shades of brownish; soft dorsal transparent with three series of black

spots, those at base fewer and larger; anal with whitish edge and dusky submarginal border; caudal with a number of dusky spots with black centers; base of upper lobe of caudal with small dusky brown blotch.

Here described from four specimens, 170 to 200 millimeters long, from the following localities: MINDORO, Mindoro Province, Calapan. ROMBLON, Romblon Province, Romblon. MINDANAO, Cotabato Province, south coast.

PARAPERCIS HEXOPHTHALMA (Cuvier and Valenciennes). Plate 2, fig. 1.

Percis cylindrica RÜPPELL, Atl. Reise Nörd. Afrika, Fische (1828) 18, pl. 5, fig. 2 (not *Sciæna cylindrica* Bloch, which is *P. cylindrica* Cuvier and Valenciennes).

Percis hexophthalma CUVIER and VALENCIENNES, Hist. Nat. Poiss. 4°. 3 (1829) 202; GÜNTHER, Cat. Brit. Mus. 2 (1860) 239; PLAYFAIR and GÜNTHER, Fish. Zanzibar (1866) 68; DAY, Fishes of India 4°. (1878) 263.

Percis polyophthalma CUVIER and VALENCIENNES, Hist. Nat. Poiss. 4°. 3 (1829) 203; PLAYFAIR and GÜNTHER, Fish. Zanzibar (1866) 68; KLUNZINGER, Fisch. Roth. Meer. 1 (1870) 816.

Percis caudimaculata RÜPPELL, Neue Wirbelthiere, Fische (1835–1840) 98; BLEEKER, Verh. Bat. Gen. 22 (1849) 54.

Parapercis hexophthalma JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1902) 466; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 103; WEBER, Siboga Exp., Fische 65 (1913) 518; BARNARD, Ann. So. African Mus. 21 (1925–27) 422, pl. 19, fig. 1; FOWLER, Mem. Bernice P. Bishop Mus. 10 (1928) 424.

? *Parapercis tetracanthus* JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1908) 281.

Dorsal V, 21; anal 18; scales on lateral line 60 to 61; between lateral line and origin of dorsal 8, between lateral line and origin of anal 19 to 23.

Body elongate, subcylindrical, its depth 5.3 to 5.6 in length; depth of compressed caudal peduncle 2.8 to 3 in head; dorsal outline at head region more arched than ventral; head pointed, 3.4 to 3.5 in length; snout quite long, 2.5 to 2.7 in head; eye large, nearer tip of snout than edge of opercle, located high, the upper margin projecting above outline of head, 4.2 to 4.6; interorbital narrow, 8.4 to 11; mouth moderate, oblique, lips broad; jaws not quite equal; premaxillaries protractile; maxillary concealed by preorbital, reaching a little beyond anterior border of eye; upper jaw with an outer series of conical teeth, with nine or ten in front enlarged, curved and caninelike, and with an inner wide band of small ones narrowing posteriorly; lower jaw with eight teeth in front and three enlarged teeth at

middle of outer series, and an inner big patch of small ones; a small patch of fine teeth on the vomer; preopercle entire with a strong rather flat spine at posterior angle.

Membrane connecting spinous and soft dorsals high; third and fourth spine about equal, almost as long as eye diameter or slightly longer; rays much higher than spines, anterior ones equal to distance from snout to pupil; anal inserted below fifth dorsal ray; pectoral rounded, 4.7 to 4.9 in body length; ventrals pointed, 4 to 4.5; caudal rounded with upper pointed lobe slightly projecting.

Scales behind occiput, on cheeks, and on breast smooth; on the rest of body and on caudal fin finely ctenoid; snout, interorbital space, and occiput naked.

Color in alcohol yellowish to grayish brown with irregularly scattered blackish spots above, whitish below; round blackish dots all over head; on sides seven to eight white, somewhat rectangular, spaces with one or several blackish spots inside, and a row of blackish spots below; three to seven black ocelli, each surrounded by a narrow white ring, the first one small, below base of pectoral, the last three along side of abdomen being persistent; in larger specimens the first four being reduced to undefined dusky spots; a black spot at base of spinous dorsal; three rows of black to brownish spots along soft dorsal, a narrow dusky strip edged with white forming a row near the tip of each ray; anal with narrow white tip, an indistinct dusky submargin, and a narrow dusky band at base, and with a row of blackish to dusky spots; caudal with a large black blotch, with a number of black spots and small white blotches behind and below.

Here described from four specimens, 185.5 to 206 millimeters, from the following localities: LUZON, Batangas Province, Hamilo. TABLAS, Romblon Province, Tablas. BALABAC, Palawan Province, Balabac.

We have also examined a specimen from Japan. None of the specimens was found to have "the oblique brown lines radiating from the lower part of the eye, over the opercles" mentioned by Playfair and Günther.

PARAPERCIS DORSONEBULOSA sp. nov. Plate 2, fig. 2.

Parapercis hexophthalmus JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 [(1906) 1907] 46 (non Bleeker).

Dorsal V, 20 to 21; anal 18; scales on lateral line 60; between lateral line and origin of dorsal 7; between lateral line and origin of anal 17 to 18.

Body elongate, subcylindrical, its depth 5.6 to 5.8 in length; caudal peduncle compressed, its depth 3.1 to 3.4 in head; dorsal and ventral profiles almost equal; head moderate, 3.3 to 3.5, with cheeks full but not bulging; snout gently sloping to spatulate tip, 2.6 to 2.8 in head; eyes large, 4.1 to 4.22; interorbital flat, 12.6 to 19; mouth large, oblique; lips broad; premaxillaries protractile; maxillary entirely concealed under preorbital, its length extending beyond anterior border of eye; lower jaw projecting; upper jaw with an outer series of enlarged teeth coarser in front and posteriorly curved canines on each side; vomer with a narrow band of villiform teeth; opercle with a rather strong spine at upper angle; subopercle terminating in a blunt flat spine.

Dorsal continuous, inserted above and slightly behind base of pectoral; third or fourth dorsal spine longest, equal to diameter of eye or slightly less; anterior dorsal rays as long as distance from snout to behind front margin of pupil or sligthly beyond; anal inserted below fifth dorsal ray; pectoral 4.6 to 5.5 in body length; ventrals short, pointed, 4 to 4.8; caudal rounded, with a projecting pointed upper lobe.

Scales somewhat coarsely ctenoid, present all over body and caudal except snout and top and sides of head, smooth scales on cheeks, behind occiput, on breast, and anterior portion of belly.

Ground color in alcohol brownish to yellowish white and brownish above in old specimens. Specimens of three months preservation in alcohol, back dusky with a number of scales here and there splashed with black; a white longitudinal band on side from above base of pectoral to base of caudal; eight to nine dusky crossbars starting from the band and disappearing below distant from median ventral line; eight to nine oblique, narrow, white lines across cheeks and anterior portion of opercle; dorsal with three rows of black dots, uppermost near edge of fin; one on anal; pectoral and ventral white to brownish; caudal with black spots and a large white blotch on posterior two-thirds of middle rays.

Type: No. 31252, in the Bureau of Science collection, 140 millimeters long, collected from Catbalogan, Samar, June, 1934, by Juan Julayco. Three cotypes, one obtained from the same place, and two from Balabac Island, Palawan Province.

Dorsonebulosa, cloudy back, in allusion to the color marking of the back.

PARAPERCIS CLATHRATA Ogilby. Plate 3, fig. 1.

Percis tetracanthus LACÉPÈDE, Hist. Nat. Poiss. 4°. (1803) 285, 302.

Percis tetracanthus BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 458; GÜNTHER, Cat. Fish. Brit. Mus. 2 (1860) 241.

Parapercis clathrata OGILBY, Proc. Roy. Soc. Queensl. 23 (1911) 41.

Parcis quadrispinosus WEBER, Siboga Exp., Fische (1913) 519.

Parapercis tetracanthus FOWLER, Mem. P. Bishop Mus. 10 (1928) 424.

Dorsal IV, 21; anal 18; scales on lateral line 59 or 60, between lateral line and origin of dorsal 7; between lateral line and origin of anal 15 to 16.

Body elongate, subcylindrical, its depth 5.7 to 6.5 in length; caudal peduncle compressed, its least depth 3.1 to 3.7 in head; dorsal profile more arched than ventral; head slightly depressed, 3.2 to 3.4 in length of body; snout moderate, gently sloping to tip, 2.8 to 3 in head; eye moderate, gently sloping to tip, 2.8 to 3 in head; eye moderate, nearer tip of snout than angle of opercular opening, its upper margin projecting above outline of head, 4 to 4.3 in head; interorbital narrow, 10.8 to 16; mouth moderate, oblique, lips slightly broad, lower jaw projecting; premaxillaries protractile; maxillaries entirely concealed under preorbital, shorter than snout, and sometimes reaching a vertical through anterior border of eyes; upper jaw with an outer series of coarse teeth with several long ones in front and sides, and with an inner villiform band narrowing posteriorly; lower jaw with an outer series of coarse teeth, four in front and three at each side, all enlarged and directed posteriorly, and an inner villiform band which is not continuous behind; vomer with a small patch of small teeth; preopercle entire, opercle with a strong rather flat spine at posterior angle.

Dorsal continuous, third spine longest and as high as vertical diameter of eye; longest rays of dorsal as long as snout or a little longer; anal inserted below fifth dorsal ray; pectoral

rounded, 4.6 to 5.5 in length; ventrals pointed, 4 to 4.57 in length of body.

Scales behind occiput, on cheeks, breast, and abdomen smooth, those on body and caudal finely ctenoid; scales absent on snout, interorbital, sides of head, and occiput.

The following color notes were taken from a live specimen, 107 millimeters long, from Basco, Batanes Province. Ground color brown, each side of body with ten vertical bars which are brown above and red below; vertical bars crossed by two longitudinal bars, upper brown and lower red with black spots; interspaces between vertical and longitudinal bars yellowish, lower parts of body fading into white. Top of head with large round black spots; sides with much smaller ones. Upper part of body brownish with rather indistinct vertical crossbands. Caudal with few black short bars and spots, and brown vertical bars. Dorsal colorless, with two rows of black spots; anal colorless, with black spots behind bases of 6th, 9th, 12th, and 15th rays.

Color in alcohol yellowish to dusky brown, becoming pale brown to white below; top of head with blackish spots, a black ocellus with narrow border of white often appearing only as a black spot immediately above angle of opercular opening; a brown to dusky brown blotch on cheeks below eyes; posteriorly a lighter blotch with black dots, faded in three specimens except for the dots; eleven rather faint crossbands on back, the first connecting the two ocelli on suprascapula and the last on the caudal peduncle; on each side nine vertical bars not continuous with the crossbands on the back; three faint brownish longitudinal bands on each side, one running from the angle of opercle to upper third of caudal peduncle, connected with the crossbands on back and the vertical bands on sides, the second, usually fainter, running straight from upper part of axilla to midst of caudal peduncle, and the third one, absent in some specimens, from immediately below root of pectoral straight to lower part of caudal peduncle; this band is narrower and connects a series of nine to ten black spots on lower part of the vertical bars the first of which lies below root of pectoral and the last on lower part of caudal peduncle; pectoral and ventral white; dorsal with three series of black spots at base of anal

which are absent or very faint in some specimens, and a series of smaller faint spots near the outer edge; caudal with a small white blotch.

Here described from four specimens, 99 to 152 millimeters, from the following localities: BATAAN, Batanes Province, Basco. CAMIGUIN, Cagayan Province, Camiguin. LEYTE, Leyte Province, Cabalian. BALABAC, Palawan Province, Balabac.

We adopt the nom. subst. of Ogilby by priority over the nom. nov. of Weber in accordance with Opinion 1 rendered by the International Commission of Zoölogical Nomenclature.

PARAPERCIS MONTILLAI sp. nov. Plate 3, fig. 2.

Dorsal IV, 21; anal 18; scales in lateral line 60, between lateral line and origin of dorsal 7, between lateral line and origin of ventral 14 to 16.

Body elongate, rather cylindrical, its depth 6 to 6.6 in length; caudal peduncle compressed, its least depth 3.2 to 3.5 in length of head which is 3.2 to 3.4 in length of body; snout rounded at tip, 3 to 3.6; eyes moderate, nearer to tip of snout than to hind edge of opercle, 4.5 to 5; interorbital space very narrow, 17.5 to 22; mouth moderate, oblique; lips slightly broad; premaxillaries protractile; maxillary concealed by preorbital, extending below anterior border of eye; lower jaw projecting; upper jaw with an outer series of enlarged teeth, which are coarse and canine-like anteriorly, and with a band of villiform teeth; lower jaw with three curved canines on each side of symphysis and a villiform band, which becomes a series of coarse teeth posteriorly; vomer with a narrow villiform band; a spine at upper angle of preopercle; subopercle terminates in a rather flat, pointed spine or in a sharp edge.

Dorsal continuous, third spine longest, as long as eye diameter; anal inserted below fifth dorsal ray; ventral pointed and short, 4 to 4.75 in length of body; caudal much rounded.

Scales ctenoid; smooth behind occiput, on cheeks, breast, and belly; snout, and top and sides of head, naked; basal half of caudal scaly.

This species differs from *P. clathrata* in its more rugged appearance and in the more defined outline of the markings, which run from dusky brown to brownish and are arranged more or less in the form of a series of chevrons. Suprascapular ocelli are absent. The markings on the head are in the form of brown blotches. A faint blotch on the anterior portion of the cheek and a darker one behind with three oblique white lines. The

black blotch at lower base of the pectoral forms a line with a series of seven to eight others on side of the belly to the lower side of the caudal peduncle. A posteromedian white blotch on the caudal.

Type: No. 31284, 137 millimeters long, in the Bureau of Science collection, collected by José Montilla, from Calapan, Mindoro, 1931. Four cotypes: One specimen, No. 4382, 134 millimeters long, collected from Zamboanga, Mindanao, June 10, 1908, by Alvin Seale; three others, No. 11438, 90 to 154 millimeters long, collected from Calapan, Mindoro, by Gregorio Lopez, January 17, 1923.

Montillai, for José Montilla, ichthyologist, Bureau of Science, Manila.

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ILLUSTRATIONS

PLATE 1

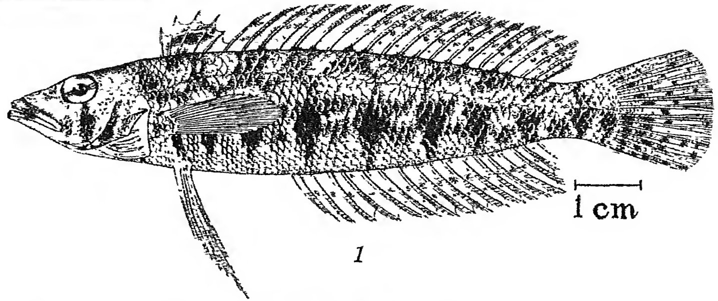
FIG. 1. *Parapercis cylindrica* (Bloch).
2. *Parapercis tetracantha* (Lacépède)

PLATE 2

FIG. 1. *Parapercis hexophthalma* (Cuvier and Valenciennes).
2. *Parapercis dorsonebulosa* sp. nov.

PLATE 3

FIG. 1. *Parapercis clathrata* Ogilby.
2. *Parapercis montillai* sp. nov.



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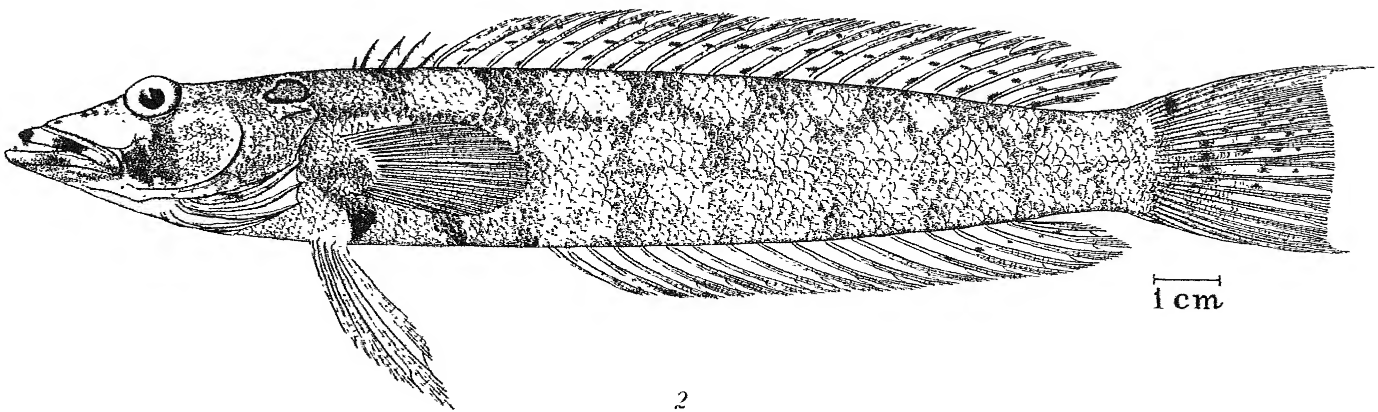

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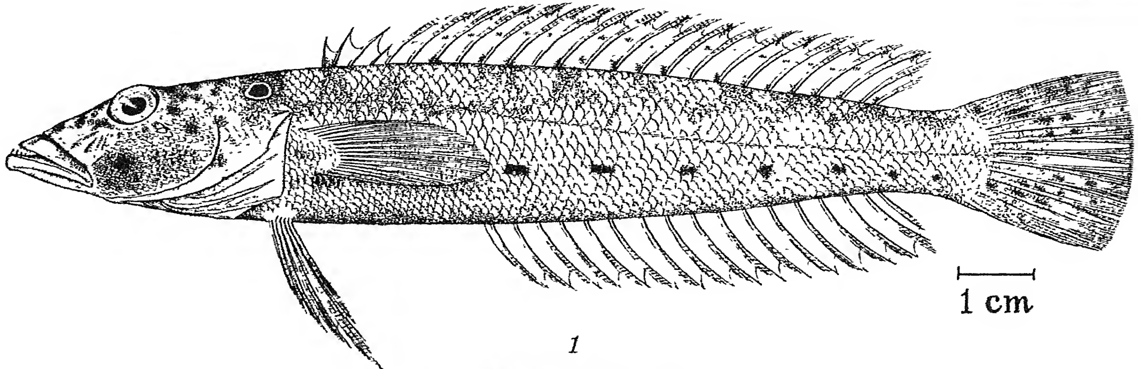
PLATE 1.



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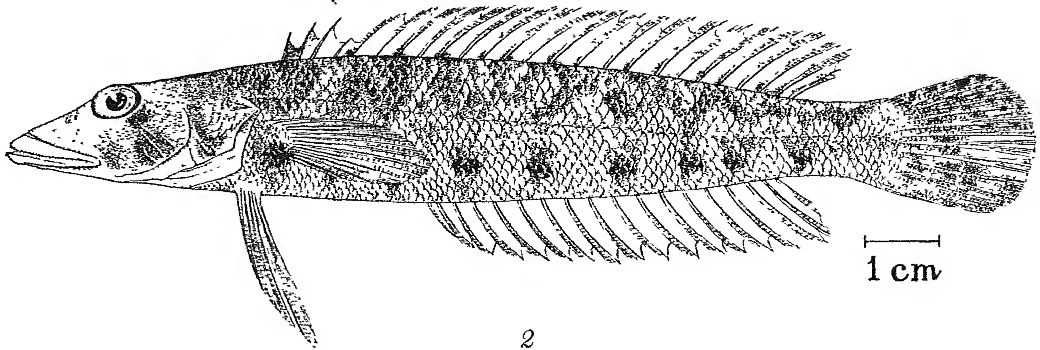

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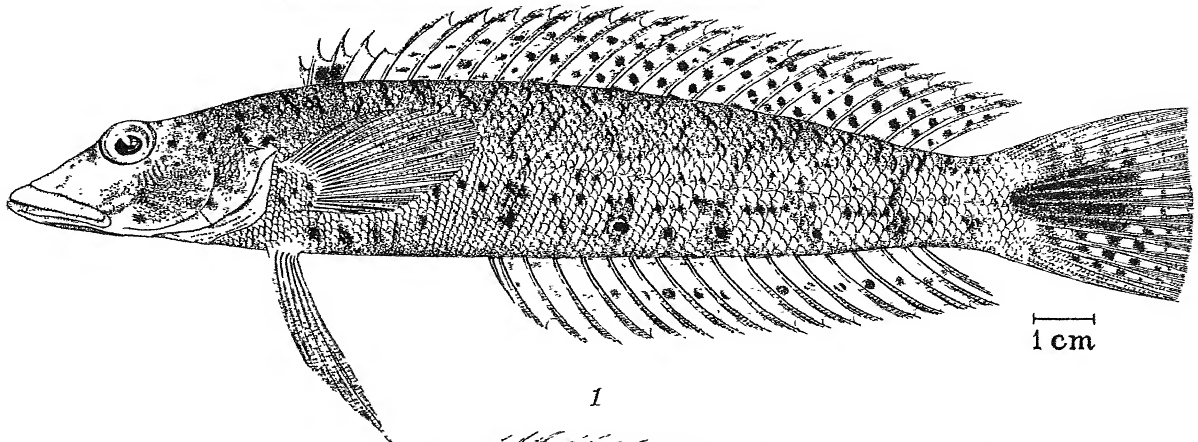
PLATE 2.



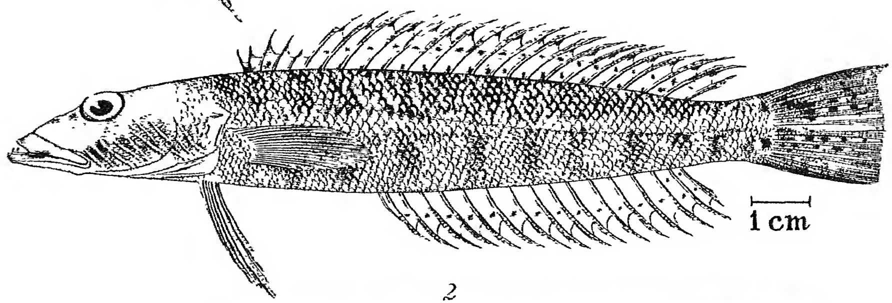


PLATE 3.

THE PHILIPPINE JOURNAL OF SCIENCE

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PHILIPPINE TOTAQUINA [1]

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Of the Bureau of Prisons, Manila

and

PAUL F. RUSSELL
Of the International Health Division of the Rockefeller Foundation

TWO TEXT FIGURES

GENERAL INTRODUCTION

Totaquina is the name suggested in 1931 by the subcommittee of experts of the Health Organization of the League of Nations (1) for a new standard preparation of the total alkaloids of cinchona bark. This product is recommended as a cheap remedy for malaria in places where the cost of quinine is prohibitive. Our paper reports some clinical results following the use of totaquina extracted at the Bureau of Science from cinchona bark of trees grown by the Bureau of Forestry in Bukidnon, Mindanao. In other words, the drug discussed in this paper is

[1] These studies were carried out with the coöperation of the Bureaus of Science, Prisons, and Forestry, together with Malaria Investigations, which is jointly supported by the Bureau of Science and the International Health Division of the Rockefeller Foundation. The cinchona bark was supplied by the Bureau of Forestry through the courtesy of Director A. F. Fischer. Totaquina was extracted at the Bureau of Science and was tested clinically at the Iwahig Penal Colony of the Bureau of Prisons, with the assistance of the staff of Malaria Investigations.

The writers desire to express their thanks to Dr. Mariano V. del Rosario, director of the School of Pharmacy, University of the Philippines, for the use of a drug mill in powdering the cinchona bark. Also to Forester Agapito L. Cenabre for information regarding cinchona bark in the Philippines.

entirely a Philippine product, produced in experimental quantities. This paper, therefore, suggests a new and potentially important local industry which might have far-reaching effects in combating malaria in the Islands.

One of us(2) has estimated that there are probably at least 2,000,000 cases of malaria a year in the Philippines. Assuming that the average quinine requirement per case is 250 grains (a low figure), it was stated that the Islands could theoretically use about 32,400 kilograms. Actually, the annual importation of quinine is frequently less than 2,000 kilograms (Table 1).

TABLE 1.—*Quantity of quinine imported into the Philippine Islands, 1898–1932.*[a]

Year.	Amount.	Year.	Amount.	Year.	Amount.
	Hectograms.		*Hectograms.*		*Hectograms.*
1899	[b] 1,489	1911	17,905	1923	13,143
1900	[b] 10,515	1912	21,811	1924	15,029
1901	[b] 8,227	1913	24,352	1925	17,422
1902	[b] 7,226	1914	23,712	1926	22,522
1903	[b] 5,251	1915	23,127	1927	19,028
1904	[b] 7,724	1916	90,731	1928	[d] 28,375
1905	[b] 11,857	1917	27,703	1929	[d] 21,442
1906	[b] 12,865	1918	76,343	1930	[d] 23,410
1907	[b] 10,841	1919	87,511	1931	[d] 20,662
1908	(c)	1920	40,703	1932	[d] 14,839
1909	(c)	1921	7,892		
1910	(c)	1922	8,560		

[a] This table is taken from Russell.(2) The figures, supplied by the Bureau of Customs, are the best available; but it must be noted that cinchona bark and quinine in various forms are included in the total. Several thousand hectograms of bark are said to be imported each year so that the figures given above are greater than the actual amount of the alkaloid quinine actually imported. The price of quinine sulphate has varied greatly and there are no records available in government or private files. The present wholesale price of quinine sulphate is 43 pesos (21.50 dollars United States currency) per kilogram (June, 1934). It is imported direct from Java.

[b] Estimated on the basis of value. Customs reports give only value and not amounts for these years.

[c] Importations of quinine not separately recorded for these years.

[d] Courtesy of the Bureau of Customs.

The estimate of 250 grains per case per year is lower than that of the League of Nations Health Organization,(3) which used 20 grams or about 308 grains per year as an average figure. But the league report estimates the quinine requirements of the Islands at only 1,305 kilograms as against the estimate of 32,400 kilograms quoted above. This discrepancy is due to the fact that in the league report the number of cases of malaria in the Philippines in 1930 is given as 64,251, an

impossible figure in view of the reported number of 15,144 malaria deaths in the same year. The disease malaria does not kill directly anything like 25 per cent of its victims. The deaths are probably not more than 1 or 2 in every 200 cases. Therefore, to account for 15,144 deaths there must have been from 1,500,000 to 3,000,000 cases, assuming the diagnosis of cause of death to have been accurate (which, of course, is often impossible). This question is discussed by one of us(2) elsewhere. We do not claim to know the correct figure, but we believe that at least 32,400 kilograms of quinine would be required to treat properly the cases of malaria now occurring each year in the Philippines. If this be true and if present quinine importations are continued, there remains a potential local market for at least 30,000 kilograms, more than 33 short tons, per year of locally produced totaquina.

It is a matter of common observation that very few cases of malaria in the provinces are adequately treated. The price of quinine sulphate varies but is commonly 1 centavo (0.5 cent United States currency) or more per grain as sold at retail, although it sells in bulk wholesale for 43 pesos (21.50 dollars) per kilogram. The retail price of one 5-grain tablet of quinine dihydrochloride is as high as 15 centavos in provincial *boticas*. At the usual retail prices a 250-grain treatment with quinine is out of the question for many thousands of malarious persons in the Philippines. Refined quinine is, in fact, an expensive luxury, a rich man's remedy. So too is atabrine, which retails for about 2.50 pesos per 15-tablet treatment. Totaquina might meet the need for a poor man's febrifuge, especially if it could be produced locally.

HISTORY

It would be interesting to recount at length the history of cinchona bark, but in this paper it must suffice merely to outline some of the important facts. This subject is admirably presented by Suppan.(4) According to this historian there is no solid foundation to support the interesting legend that we owe our first knowledge of the febrifuge qualities of cinchona to Peruvian Indians. For instance, from the discovery of Peru by Spaniards in 1513 to the beginning of the seventeenth century, none of the observers who wrote of their experiences in South America mentioned in any way a febrifuge bark. Moreover, the Indians themselves, after the Spaniards had learned of this bark, refused to use it as a medicine even after the properties were explained to them.

According to Suppan, it is highly probable that Jesuit missionaries were the first to discover the virtues of cinchona bark at some date and place still unrevealed. The first-known use of powdered cinchona bark to cure malaria was in 1630 when Don Juan Lopes de Cannizares, Spanish corregidor of Loxa, Peru, was successfully treated. In 1638, this corregidor sent some bark for the treatment of Countess Chinchon, wife of the viceroy of Peru. Having first tried it on a number of patients, her physician, Dr. Juan de Vega, gave some to the countess, with brilliant results. She was so grateful that she secured another supply and gave it gratis to all who applied at her palace. Hence its first popular name, *polvo de la Condesa.* So many applied for this remedy that she turned over to Jesuits the task of distributing it. The name then became *polvo de los Jesuitos* or *polvo de los padres.*

It is not clear exactly when the bark was first sent to Europe, but soon after 1640 it was widely known, largely because of the activity of Jesuit fathers, among whom Cardinal de Lugo was most enthusiastic. Hence another name—*pulvis cardinalis.* In 1649 this cardinal cured in Paris the dauphin who later became Louis XIV. This success naturally called widespread attention to powdered bark, which was becoming commonly known as *pulvis Peruanus* or *Peruvianum febrifugum.*

Just when the powdered bark first came to the Orient is uncertain, but it is recorded that in 1692 Jesuit priests in China used it to cure Emperor K'ang Hsi of a dangerous fever. It is not unlikely that supplies of the bark had also come to the Philippines at this early date. The Jesuits were absent from the Philippines from 1768 to 1852, but it seems very probable that they had imported supplies of this febrifuge prior to their departure. However, we have not been able to find any definite record of this. The fact that Filipinos have used bitter powdered bark from such local trees as *dita* [*Alstonia scholaris* (L.) R. Br.] as a febrifuge for more than one hundred years, is probably accounted for by a similarity in taste to powdered Peruvian bark.

Not until 1740 was a description of the fever-bark tree published in Europe. La Candomine, a French scholar, sent drawings and a description to Paris, and two years later Linnæus established the genus *Cinchona.* He misspelled the name of the countess whom he sought to honor, but the International Botanical Congress held in Paris in 1866 voted to retain his spelling.

In 1752 the Spanish Government began to organize the bark trade. It also searched for cinchona trees in regions other than Peru, finding them in Chile, Ecuador, and Bolivia. It may be noted that cinchona trees have never been found growing naturally in any part of the world other than this limited South American region.

The researches done by Humboldt and by Weddell were of great importance in spreading information regarding the collection and preparation of the barks and their botanical classification.

In 1820 two French pharmacists isolated quinine and cinchonine from the bark. The discovery of quinine, in particular, led to an enormous increase in the demand for bark. There followed a rapid and reckless destruction of cinchona trees, so that the supply was in danger of exhaustion. This suggested the possibility of cultivating cinchona elsewhere. Java was suggested in 1837 and India in 1839.

The Dutch were first to bring cinchona trees to the Orient. Hasskarl, superintendent of gardens in Java, left Peru in 1854, arriving in Batavia after a journey lasting four months. All but two of his plants died during the journey or afterwards. However, with his surviving specimens, augmented by later concessions, he was successful, and was knighted for his achievement.

The British had tried unsuccessfully in 1852 to raise cinchona from seeds sent to Calcutta; but in 1860, due to the efforts of Markham and Spruce, they were able to start growing cinchona in India. Their supplies came partly from South America and partly from Java. By 1866 there were more than 1,500,000 cinchona plants growing on the Nilgiri Hills, in southwest India, and this number had nearly doubled by 1872. In 1861 another cinchona plantation had been started in Ceylon.

The cultivation of cinchona in Java and India has continued, Java producing about nine-tenths of the bark of the world. The chief species now of commercial importance are *Cinchona ledgeriana* Moens, *C. calisaya* Weddell, *C. officinalis* Linnæus, *C. hybrida,* and *C. succirubra* Pavon. The first named has the highest quinine content.

About thirty alkaloids have been isolated from cinchona bark. The four chief alkaloids have been isolated as follows:

Quinine, 1820, isolated by Pelletier and Caventou.

Cinchonine, 1820, isolated by Pelletier and Caventou. (Gomez, 1810, made a partial separation of cinchonine.)

Quinidine, 1846, isolated by van Heijningen.
Cinchonidine, 1847, isolated by Winkler.

In both Ceylon and India the cultivation of cinchona was largely given up in order to produce the more-profitable tea, so that at present there is in reality a Dutch monopoly. Lately there has been a revival of interest in cinchona planting in India. Experimental cinchona is grown in certain areas of Africa, Indo-China, Malaya, and the Philippines, and in a few other regions. It does not appear that any unfair advantage has been taken of their monopoly by the Dutch. In fact there has been complaint about overproduction with insufficient returns on the investment. Certainly the Dutch have kept pace with the demand for quinine and have made every effort to reduce the costs of production.

Nevertheless, there is a serious world shortage in terms of the amount required by the estimated number of malaria patients in the world to-day. This is due in part to faulty distribution in malarious regions, but the chief reason is the fact that millions of sufferers cannot afford to buy quinine even at its relatively low price. Therefore, there is a very large field for the production of a still lower-priced product, such as totaquina. As noted above, there is a potential market in the Philippines alone for more than 30,000 kilograms a year. Totaquina cannot be considered to be a direct competitor of either quinine or the synthetic antimalaria drugs. It is required by malarious consumers who literally cannot afford to buy higher-priced drugs.

CINCHONA IN THE PHILIPPINES

The first reference we have found to cinchona growing in the Philippines is contained in a short note(22) about the "Jardin Botánico." The director of this garden in 1893 is reported to have said that he would like to acclimatize "Sinconas" at the foot of the Banahao mountains in Tayabas and also in Munang near Antipolo. There is nothing in this note to indicate that this was done, and we have found no further reference to it.

According to Fischer and Cenabre(5) it is safe to state that cinchona can be grown in the Philippines on areas properly located. They note that although it is commonly believed that cinchona is very delicate to handle, according to their ex-

perience and careful observation, the problem is not exceptionally difficult.

It appears that the first attempt to grow cinchona in the Islands was made in 1912 in Baguio, Mountain Province, and in Los Baños, Laguna, by the Bureau of Forestry. These attempts failed, as did several later ones. In 1916 three hundred plants were set out, but very few survived. In this same year Wester,(6) a horticulturist, stated, after visiting some cinchona plantations in Java, that the soil and climate of some parts of southeastern Bontoc appeared to be favorable for cinchona. He suggested that the Government consider the introduction of cinchona in those areas. It does not appear that his suggestion was followed, but an anonymous note(7) of 1919 stated that the introduction of cinchona plants into the Islands from India was being attempted by "the Igorot Exchange, a missionary institution in Sagada." Some 10 ounces of seed of *C. ledgeriana* was received from Ootacamund, Madras. According to the Right Reverend Bishop Mosher, this experiment apparently did not succeed, as no evidence of it remains in Sagada.

In 1927, according to Fischer and Cenabre(5) and Altamirano,(8) the Bureau of Forestry, with funds made available by the Reforestation Act, started a cinchona nursery in Impalutao, Bukidnon, Mindanao, using seeds from Java. This area has an altitude of about 762 meters, with an average rainfall of 112 inches annually, and temperature ranging from 17° to 29° C. The attempt has been successful, and an area of nearly 14 hectares has been planted to cinchona. There were 67,000 seedlings in the nursery ready for transplanting in 1933. There are now about 38,000 trees on the plantation itself, some 11,000 bearing fruit since 1930, and some 1,100 three or more years old. The species present are *C. ledgeriana, C. succirubra,* and *C. hybrida.*

Some bark from 5-year-old trees was analyzed with the following comparative results:(9)

TABLE 2.—*Cinchona bark analyses.*

Species.	Percentage of alkaloids.		
	Bukidnon.	India.	Java.
	Per cent.	*Per cent.*	*Per cent.*
Cinchona ledgeriana	9.6	8.52	8.6 (6.5–11.0)
Cinchona hybrida	4.74		
Cinchona succirubra	4.56	6.25	7.7

A second area in Bukidnon has been planted. This is at Barrio Alanib, in Malaybalay, and has an elevation of 1,067 to 1,372 meters. The trees are growing even better in this second location.

Quoting former Vice-Governor-General C. Butte,(9) who visited the plantations: "I can conceive of no production that would be more beneficial to all the people in these Islands, both from the commercial and the public standpoint, than the production of quinine within our country."

The authors of this paper would subscribe to this statement provided for "quinine" is read "totaquina." It is doubtful if the Philippines or any other country could successfully compete with the Dutch in the manufacture of the separated alkaloid quinine, but totaquina could certainly be produced and would find a very large potential market within the Islands.

TOTAQUINA

As a result of several conferences and considerable research the Malaria Commission of the League of Nations(10) suggested that a new cinchona product be prepared. This is to be called "totaquina," and is to be a standardized mixture of the combined alkaloids in cinchona bark, as follows:

Crystallizable alkaloids.—Not less than 70 per cent. Not less than 15 per cent of these alkaloids to be quinine.

Amorphous alkaloids.—Not to exceed 20 per cent.

Moisture.—Not more than 5 per cent.

Mineral matter.—Not more than 5 per cent.

Two types of totaquina have been prepared in commercial practice, as follows:

Type I.—Made by extracting and precipitating as an almost white powder the total alkaloids from the bark of *C. succirubra* or *C. robusta,* which can be cultivated in many malarious countries. This is the preferred type. It is the one we have in mind for the Philippines.

Type II.—Utilizing the residue remaining after quinine sulphate has been extracted from *C. ledgeriana* and bringing the preparation up to the required standard by adding sufficient quinine and other crystallizable alkaloids.

In this connection Howard,(11) who was in a position to know, stated that some of the advocates of cheap febrifuge mixtures appear to believe that there are vast quantities of cinchona products being wasted, which could be used (as in Type II totaquina). Howard said that he had no knowledge

of the existence of any hoards of residual alkaloids anywhere in the world.

The commission pointed out that the term "cinchona febrifuge," which was as heretofore applied to various mixtures of the alkaloids, should be discarded in favor of standardized totaquina. The name "quinetum" should be used only for a preparation containing quinine, cinchonidine, and cinchonine in equal parts.

The commission(10) reports that Giemsa(12) found totaquina a little more toxic than hydrochlorate of quinine when given in the same doses intravenously to rabbits. He found totaquina, both types, somewhat inferior to quinine in avian malaria (*Plasmodium relictum*). Giemsa, after a number of tests, concluded that the therapeutic efficacy of totaquina was directly proportional to the amount of quinine present.

Also cited by the commission are some tests by James(10, 13) in cases of benign tertian malaria intentionally induced by the bites of mosquitoes. The samples he used were composed as follows:

TABLE 3.—*Composition of samples used in tests by James.*

Constituent.	Type I. [a]	Type II. [b]
	Per cent.	*Per cent.*
Quinine	33.4	15.3
Cinchonine	21.7	55.4
Cinchonidine	34.7	5.7
Quinidine	0.0	5.2
Total crystallizable alkaloids	89.8	81.6
Amorphous alkaloids	5.3	13.4
Moisture	0.76	1.9
Ash	0.6	2.1

[a] Type I consisted of total alkaloids of *C. succirubra.*
[b] Type II was composed of quinine residues.

James's(10) results may be quoted as follows: (*a*) One dose of 5 grains (0.3 gram) of totaquina of either type has practically no effect on the fever or parasites. It is necessary, therefore, to use a single dose of 10 grains (0.6 gram) for the test. (*b*) A single dose of 10 grains of totaquina Type I produces the same effect in aborting the fever and in reducing the parasites as that produced by a single dose of 5 grains of quinine. (*c*) A single dose of 10 grains of totaquina Type II has practically no effect in aborting the fever or in reducing the parasites. With this type of totaquina it is necessary to use a single

dose of 20 grains (1.2 grams) to produce the same effect as that produced by a single dose of 5 grains of quinine.

James(10) concludes as follows:

It appears from these results that totaquina Type I (total alkaloids of *C. succirubra* or *C. robusta*) when used in ordinary clinical therapeutic doses for curative purposes—e. g. 1.2 gram (20 grains) daily for five to seven days—should give about the same good result as is given by quinine in the same doses. If this is so, and if this type of totaquina can be obtained more cheaply than quinine, it would be advantageous to use it for general purposes instead of the single alkaloid.

The method by which Type I in the above tests was prepared is given by Groothoff and Henry(13) as follows:

The process used was that described by Schwyzer, Fabrikation der Alkaloide, Berlin (1927), which depends on the extraction of the alkaloids from the ground bark, previously mixed intimately with slaked lime, by boiling benzene. From the benzene solution the alkaloids are in time removed by agitation with dilute sulphuric acid. The aqueous alkaloidal solution so obtained is decolourized by heating with charcoal, filtered, and, while still hot, run into excess of sodium hydroxide solution to precipitate the alkaloids. After standing for several hours the precipitate is collected, washed with water and allowed to dry in the air.

The samples obtained were nearly white or pale cream-colored powders, completely soluble in dilute sulphuric acid, giving a fluorescent solution.

The British Pharmacopoeia(14) includes totaquina (totaquine), giving its characters, tests for identity and purity, and its assay.

According to Dawson,(15) who cites Henry,(16) the four common cinchona alkaloids are really two pairs of optical isomers, quinine and quinidine forming one pair, and cinchonidine and cinchonine the other. Quinine and cinchonidine are levorotatory, and quinidine and cinchonine are, respectively, their dextrorotatory isomers. Dawson,(15) after reviewing the literature, states that quinine and quinidine are of practically equal value in the therapy of malaria of any species. All four alkaloids are about equal in their efficacy against chronic benign tertian malaria.

Totaquina would replace such preparations as quinetum, first extracted in Java in 1874, which was not standardized and did not prove to be economical. It was a coarse preparation of mixed alkaloids. So, too, a cinchona febrifuge similar to but better than quinetum was never well standardized. The Indian cinchona febrifuge came to be a residual alkaloidal rather than

a total alkaloidal preparation. Nevertheless, cinchona febrifuge has had considerable use and value. It has become the most important of the commercial alkaloid preparations.

It may be noted that the usefulness of the other alkaloids of cinchona in malaria therapy has been well known since 1866–1867 when three Madras Commissions in India reported favorably after extensive experiments. There has been ample confirmation by Fletcher(17) and others. Field(18) has recently reported some observations that led him to conclude that totaquina gives excellent results in malaria therapy. The subject is also reviewed by Sinton,(19) especially as to the place of cinchona febrifuge in malaria therapy.

PREPARATION AND ANALYSIS OF TOTAQUINA

The totaquina used in this investigation was prepared from the ground bark of *Cinchona ledgeriana*, which was grown at the Philippine Bureau of Forestry Station at Impalutao, Bukidnon, Mindanao. As previously stated, the bark of this *Cinchona* species has a higher percentage of total alkaloids than those of *C. succirubra* and *C. hybrida*, which are also grown there.

The results of our analysis of Philippine *Cinchona ledgeriana* bark, according to the method of Howard and Chick,(20) are given in Table 4. As shown by the data, this bark has a rather high percentage of total alkaloids, more than half of which is quinine.

TABLE 4.—*Analysis of the dried bark of Philippine Cinchona ledgeriana.*

Constituent.	Per cent.
Quinine	5.51
Cinchonidine	1.45
Quinidine	1.94
Cinchonine	Trace.
Amorphous alkaloids	0.72
Total alkaloids	9.62

Preliminary experiments were carried out in order to ascertain a satisfactory method for making totaquina from cinchona bark. As a result of our experiments, we made three preparations which are recorded as A, B, and C.

The method used for making totaquina A was essentially the same as that recommended for the preparation of "quinetum" from *Cinchona succirubra*.(21) The result was not so satis-

factory, as we obtained a dark brown powder that was only partly soluble in dilute sulphuric acid.

Our preparation of totaquina B gave better results. The method for this preparation was very similar to that employed in making totaquina A, except that the precipitated alkaloids were dissolved in dilute sulphuric acid (about 0.2 *N*) and filtered to remove insoluble impurities. The acid filtrate was heated and then decolorized with purified charcoal. The hot solution was then made strongly alkaline with sodium hydroxide solution in order to precipitate the alkaloids. When cooled, the precipitate was collected on a filter, washed with water, and dried in a vacuum oven below 50° C. Totaquina B has a light brown color but is not completely soluble in dilute sulphuric acid, though much more nearly so than totaquina A.

Our third preparation, totaquina C, gave the best results. This product was made in the following manner: The finely powdered cinchona bark was macerated with dilute hydrochloric acid. The mixture was then poured into a percolator and the extraction completed with water as the solvent. The acid percolate was treated with a sufficient amount of sodium hydroxide solution to precipitate the coloring matter as flakes. After the coloring matter had been removed, the solution, which was still strongly acid, was made strongly alkaline with sodium hydroxide solution. The mixture was set aside overnight and the alkaloids that separated from the turbid liquid were removed by filtering. They were washed with water until the washings were almost colorless, and dried. This represented the first portion of the totaquina. The filtrate from the first portion contained a considerable quantity of alkaloids in suspension. These were precipitated (salted out) with sodium chloride. After standing for several hours, the supernatant liquid was removed and the precipitate collected on a double filter and washed with water. The precipitate was treated with dilute sulphuric acid and filtered to remove impurities. The acid filtrate was decolorized with animal charcoal and the hot solution precipitated with an excess of sodium hydroxide. The precipitate was removed, washed with water, and dried, after which it was extracted with hot ethyl alcohol (95 per cent). The alcoholic extract was distilled to remove the excess alcohol. The residue was evaporated to dryness and incorporated with the first fraction of the alkaloids previously obtained. A kilogram of powdered cinchona bark gave 90 grams of totaquina C or a yield of

9 per cent. A complete assay of the bark (Table 4) gave 9.62 per cent of total alkaloids. The yield of totaquina C is, therefore, about 93 per cent of the total alkaloids in the bark.

This product, totaquina C, was a pale brown powder, which dissolved easily and completely in dilute sulphuric acid, giving a blue fluorescent solution.

The alkaloidal constituents of totaquina B and C were determined according to the method of Howard and Chick.(20) The results are recorded in Table 5. Instead of determining the quinine by weighing the dried quinine sulphate, we dissolved the salt in hot neutral ethyl alcohol and titrated the solution with alcoholic potassium hydroxide (0.1 *N*), using phenolphthalein as indicator.

TABLE 5.—*Analysis of totaquina preparations from the bark of Philippine Cinchona ledgeriana.*

Constituent.	Totaquina preparations. B	Totaquina preparations. C
	Per cent.	*Per cent.*
Quinine	42.01	53.90
Cinchonidine	18.82	21.98
Quinidine	10.08	14.71
Cinchonine		
Total crystallizable alkaloids	70.91	90.59
Amorphous alkaloids	15.54	5.85
Total alkaloids	86.45	96.44
Moisture	5.14	1.55
Ash	3.23	1.91
Organic impurities (by difference)	5.18	0.10

As shown by the data (Table 5) totaquina C is a better product than totaquina B because it contains not only more of the total crystallizable alkaloids but also more quinine.

The cost of preparing totaquina C in our laboratory was approximately 16.07 pesos per kilogram. This includes the average cost of cinchona bark (87 centavos per kilogram), as given by the Bureau of Forestry (see below), and incidental expenses for chemicals and labor. The estimated expenses are itemized as follows:

Cinchona bark, 11.1 kilos	9.66
Concentrated hydrochloric acid, 610 cc	1.60
Sodium hydroxide, 597 g	1.36

	Pesos.
Sodium chloride, 1 kg	0.20
Concentrated sulphuric acid, 100 cc	0.20
Charcoal, 500 g	0.65
Ethyl alcohol, 1 kilo	0.20
Filter paper, 10 sheets	0.20
Total cost of materials	14.07
Labor	2.00
Total expenses	16.07

This is a laboratory cost. In commercial production the cost would doubtless be less. As stated above the wholesale price of quinine sulphate in bulk is 43 pesos per kilo (the Government pays 40 pesos). In 5-grain tablets the wholesale price is 14 pesos per 1,000 tablets (the Government pays 12 to 13 pesos). This price for tablets is practically equivalent to the price for the powder.

Boticas, or drug stores, in the provinces, charge 1 centavo a grain for quinine sulphate, as an average minimum. The price is not infrequently doubled in places where the demand is greatest. At 1 centavo a grain the retail cost of quinine sulphate becomes 154 pesos per kilogram.

Obviously, totaquina can be sold for much less than that. We submit the following estimate of the retail cost of a kilogram of totaquina as a fair approximation:

	Pesos.
Cinchona bark (This allows a fair profit to the grower. See table below.)	9.66
Preparing the totaquina (This allows a 15 per cent profit on production costs of 6.41 pesos as set forth above.)	7.37
Wholesale price per kilo	17.03
Allowance for retailer's profit and expenses, 20 per cent	3.40
Retail price of totaquina to consumer, per kilo	20.43

This estimated retail price of 20.43 pesos per kilogram of totaquina is higher than it would be if production were carried on commercially, but it compares very favorably with the present retail price of 154 pesos for quinine sulphate. If retailers were now limited to a 20 per cent profit, the retail price of quinine sulphate would be 51.60 pesos per kilogram, more than two and a half times the liberally estimated totaquina price. But since established prices are not easily changed it is perhaps fair to

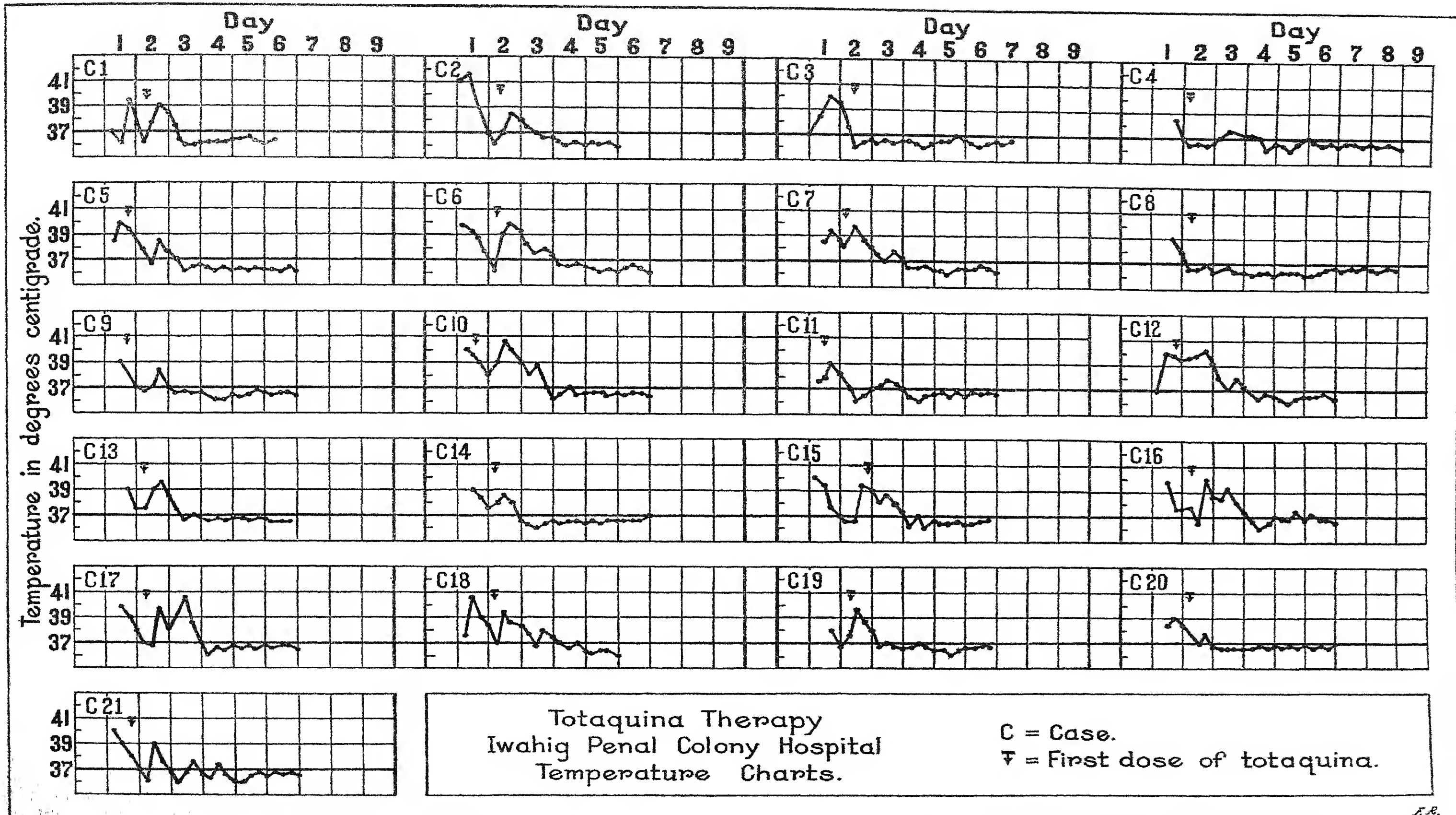

FIG. 1. Temperature charts, totaquina therapy, Iwahig Penal Colony Hospital. Patients were hospitalized for at least fifteen days. The part of the temperature charts not shown above presented only normal temperature.

contrast the present actual retail price of quinine of 154 pesos with the estimated price of 20.43 pesos for totaquina, which as a new drug being introduced by the Government could from the first be subject to some price restrictions under official supervision. If this comparison is used the totaquina could be sold to the people for something like one-seventh of the present price of quinine! In this case a 250-grain treatment would cost not 2.50 pesos, as at present, but only about 35 centavos, a price within the means of the malarious poor. If sold to the people by the Government, eliminating the retailer's profit, the price would be even less.

CLINICAL TEST OF TOTAQUINA

In this study of totaquina, twenty-one frank cases of malaria having positive blood examination for parasites were selected for trial. Particular attention was given to its effect upon chills and fever and upon schizonts and gametocytes of the two common types of malaria infections; namely, the benign tertian, caused by *Plasmodium vivax*, and the malignant tertian, caused by *Plasmodium falciparum*. Observations were made as to any untoward effects which could be attributed to the drug. Careful clinical histories as well as physical examinations of the cases for trial were noted, and blood examinations made at intervals before and during the administration of the drug. Thick and thin smears were stained with Giemsa, and each thin smear was examined for at least thirty minutes if negative.

DOSAGE

Totaquina was given in the same dosage as quinine in the treatment of malaria; namely, 0.6 gram three times a day for adults. It is not so bitter as quinine and hence can be administered to children in papers with lactose. Children less than 2 years of age were given 0.2 gram three times a day. Totaquina sample A was used to treat cases 1 and 2; sample B, cases 3 to 16, 19, and 20; sample C, cases 17, 18, and 21.

MALARIA CASES GIVEN TOTAQUINA IN IWAHIG PENAL COLONY HOSPITAL

CASES OF BENIGN TERTIAN TYPE

Cases 1 to 18 were all diagnosed as benign tertian (case 13 was a mixed infection with subtertian). All were Filipino males unless otherwise stated. Fever charts are given in fig. 1, and a record of blood smear examinations in Tables 6 and 7, and

fig. 2. The physical examination was normal unless otherwise stated.

CASE 1. C. L., AGE 53 YEARS, ADMITTED APRIL 11

Clinical history.—Fever and chills accompanied by headache and profuse sweating regularly every afternoon for three days. Spleen three-fingers' breadth, palpable at left costal margin on normal respiration.

Treatment.—Totaquina, 0.6 gram three times a day for fifteen days.

Observation.—Two days after administration of the drug temperature became normal. Spleen receded in size until at the time of discharge it was palpable on deep inspiration.

CASE 2. F. P., AGE 33 YEARS, ADMITTED APRIL 11

Clinical history.—Chills and fever every other day for three days. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for fifteen days.

Observation.—One day after administration of the drug temperature became normal. No more chills. The 3d day no malarial parasites could be seen in thick smear.

CASE 3. R. S., AGE 24 YEARS, ADMITTED JUNE 13

Clinical history.—Fever and headache for two days. Spleen palpable on deep inspiration.

Treatment.—Totaquina, 0.6 gram three times a day for ten days, then reduced to 0.3 gram. t. i. d. until the 15th day.

Observation.—After administration of the drug there was no further rise of temperature. Two days after, the blood became negative for malarial parasites and remained so. The 12th day spleen no longer palpable.

CASE 4. C. C., AGE 54 YEARS, ADMITTED JUNE 14

Clinical history.—Fever, chills, and headache every afternoon for four days. Spleen not palpable.

TABLE 6.—*Blood-smear examinations. Totaquina therapy. Iwahig Penal Colony Hospital.*[a]

[+, Positive, but fewer than 1 per 100 leucocytes.]

Case.	Initial.	Date.	Parasites per 100 leucocytes.		Species.
			Asexual.	Gametocytes.	
1	C. L.	Apr. 11	63	0	*Plasmodium vivax.*
		Apr. 12	4	0	Do.
2	F. P.	Apr. 11	238	0	Do.
		Apr. 12	20	0	
3	R. S.	June 13	+	0	Do.
		June 14	+	0	
		June 15	0	+	
4	C. C.	June 15	11	0	Do.
		June 16	1	0	
		June 17	1	0	

[a] A complete record of negative examination is given in text fig. 2.

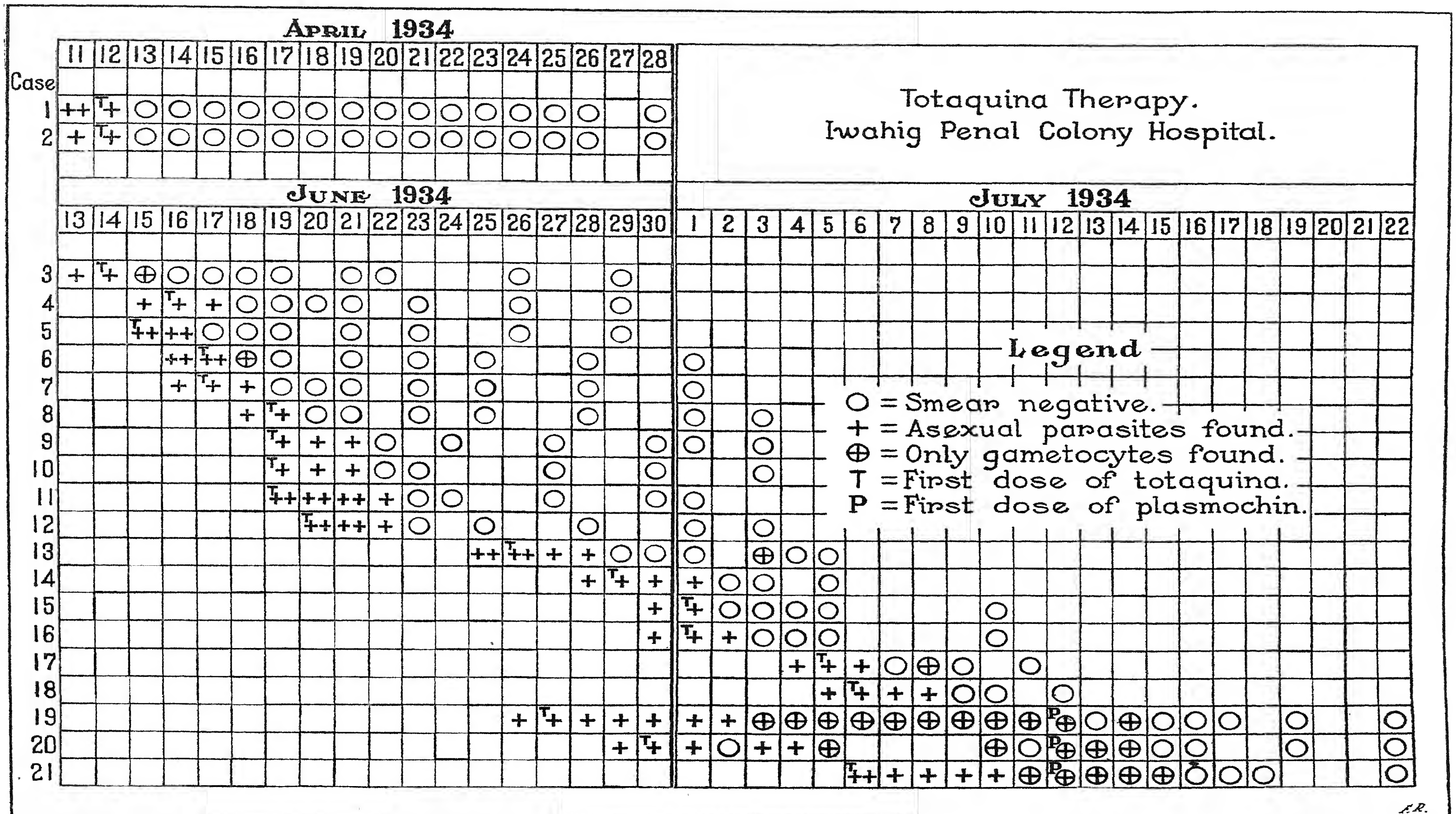

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FIG. 2. Totaquina therapy, Iwahig Penal Colony Hospital. Blood-smear chart.

TABLE 6.—*Blood-smear examinations. Totaquina therapy. Iwahig Penal Colony Hospital.*[a]—Continued

Case.	Initial.	Date.	Parasites per 100 leucocytes. Asexual.	Gametocytes.	Species.
5	O. P.	June 15	48	0	*Plasmodium vivax.*
		June 16	138	2	
6	R. R.	June 16	306	0	Do.
		June 17	68	0	
		June 18	0	+	
7	F. C.	June 16	250	0	Do.
		June 17	208	2	
		June 18	20	0	
8	A. P.	June 18	5	0	Do.
		June 19	4	0	
9	F. G.	June 19	147	0	Do.
		June 20	86	0	
		June 21	4	0	
10	B. O.	June 19	170	0	Do.
		June 20	6	0	
		June 21	6	0	
11	F. A.	June 19	80	0	Do.
		June 20	4	0	
		June 21	+	0	
		June 22	+	0	
12	A.	June 20	18	0	Do.
		June 21	4	0	
		June 22	+	+	
13	P. C.	June 25	316	10	Mixed *Plasmodium vivax* and *falciparum.*
		June 26	256	42	
		June 27	4	2	
		June 28	2	+	
		July 3	0	+	
14	S. M.	June 28	302	0	*Plasmodium vivax.*
		June 29	68	0	
		June 30	1	0	
		July 1	+	0	
15	B. d. V	June 30	57	0	Do.
		July 1	2	0	
16	E.	June 30	209	0	Do.
		July 1	40	0	
		July 2	4	0	
17	S. D.	July 4	130	0	Do.
		July 5	2	0	
		July 6	10	4	
		July 8	0	+	
18	S. T.	July 5	205	0	Do.
		July 6	104	0	
		July 7	40	0	
		July 8	+	0	

[a] A complete record of negative examinations is given in text fig. 2.

TABLE 6.—*Blood-smear examinations. Totaquina therapy. Iwahig Penal Colony Hospital.*[a]—Continued

Case.	Initial.	Date.	Parasites per 100 leucocytes. Asexual.	Parasites per 100 leucocytes. Gametocytes.	Species.
19	S. M	June 26	148	0	*Plasmodium vivax* and *falciparum.*
		June 27	74	0	
		June 28	4	2	
		June 29	+	+	
		June 30	2	2	
		July 1	2	2	
		July 2	2	2	
		July 3	0	+	
		July 4	0	+	
		July 5	0	+	
		July 6	0	+	
		July 7	0	+	
		July 8	0	+	
		July 9	0	+	
		July 10	0	2	
		July 11	0	+	
		July 12	0	+	
		July 13	0	0	
		July 14	0	+	
20	J. B	June 29	90	0	Do.
		June 30	4	0	
		July 1	+	0	
		July 2	0	0	
		July 3	+	0	
		July 4	+	0	
		July 5	0	+	
		July 10	0	2	
		July 11	0	0	
		July 12	0	+	
		July 13	0	+	
		July 14	0	+	
21	M. C	July 6	86	0	Do.
		July 7	4	2	
		July 8	2	2	
		July 9	6	6	
		July 10	2	2	
		July 11	0	4	
		July 12	0	4	
		July 13	0	2	
		July 14	0	3	
		July 15	0	4	

[a] A complete record of negative examinations is given in text fig. 2.

Treatment.—Totaquina, 0.6 gram three times a day for eight days, then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Two days after administration of the drug temperature became normal. The 4th day blood smear became negative.

CASE 5. O. P., IGOROT, AGE 22 YEARS, ADMITTED JUNE 15

Clinical history.—Fever, headache, and chills with profuse perspiration each afternoon for two days. Spleen palpable on deep inspiration.

Treatment.—Totaquina, 0.6 gram three times a day for nine days, then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Two days after administration of the drug temperature became normal and blood negative. After ten days' treatment spleen receded and could no longer be palpated on deep inspiration.

CASE 6. R. R., AGE 33 YEARS, ADMITTED JUNE 16

Clinical history.—Fever and headache, vomiting for two days. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for seven days, then reduced to 0.3 gram until the 15th day.

Observation.—Two days after administration of the drug fever subsided and blood became negative the next day.

TABLE 7.—*Disappearance of parasites following totaquina therapy.*[a]

Parasites disappeared—	Cases.	
	Asexual parasites.	Gametocytes.
	Cases.	*Cases.*
In 1 day	6	0
In 2 days	5	4
In 3 days	6	2
In 4 days	1	1
In 5 days	2	0
In 6 days	1	0
In 8 days	0	1
In 10 days	0	1
In 18 days	0	1
Total	21	10

[a] In the history records the day is usually counted from that of admission. In the above table it is counted from the time the first dose of totaquina was given.

CASE 7. F. C., AGE 31 YEARS, ADMITTED JUNE 16

Clinical history.—Fever and chills followed by profuse perspiration every afternoon for three days. Spleen palpable on deep inspiration.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Two days after administration of the drug temperature became normal and blood smear negative the following day. Spleen still palpable on deep inspiration, at time of discharge.

CASE 8. A. P., AGE 27 YEARS, ADMITTED JUNE 18

Clinical history.—Headache, fever, and chilly sensation for two days. Spleen palpable on deep inspiration.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—The drug was administered at the time of subsidence of fever, which did not rise again. The next day blood smear became negative. The 6th day spleen no longer palpable on deep inspiration.

CASE 9. F. G., AGE 30 YEARS, ADMITTED JUNE 19

Clinical history.—Fever, headache, and chills in the afternoon for two days. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for seven days, and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Two days after administration of the drug temperature became normal. Blood negative the 4th day.

CASE 10. B. O., AGE 27 YEARS, ADMITTED JUNE 19

Clinical history.—Fever, headache, and chills coming every afternoon regularly for three days. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—After three days' administration of the drug temperature went to normal, and blood smear became negative.

CASE 11. F. A., AGE 47 YEARS, ADMITTED JUNE 19

Clinical history.—Fever, headache, and chills for two days each morning. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Three days after administration of the drug temperature became normal. Blood became negative the 5th day.

CASE 12. A., IGOROT, AGE 24 YEARS, ADMITTED JUNE 20

Clinical history.—Fever, headache, and chills, followed by profuse sweating coming every other day. Spleen palpable on inspiration.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Three days after administration of the drug temperature became normal and blood smear negative. The 9th day, spleen could no longer be palpated on inspiration.

CASE 13. P. C., AGE 37 YEARS, ADMITTED JUNE 25

Clinical history.—Fever, headache, and chills coming each afternoon for two days. Patient had chills in the ward. Spleen three fingers' breadth below left costal margin.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Mixed infection, tertian and subtertian. Two days after administration of the drug temperature became normal. The 5th day blood smear became negative. Crescent seen the 9th day, blood thereafter negative. After six days of treatment spleen became palpable on inspiration.

CASE 14. S. M., AGE 27 YEARS, ADMITTED JUNE 28

Clinical history.—Fever, headache, and chills for four days regularly every afternoon. Spleen two fingers' breadth below left costal margin.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until 15th day.

Observation.—One day after administration of the drug temperature became normal. The 5th day blood smear became negative. The 13th day spleen could no longer be palpated on inspiration.

CASE 15. B. V., AGE 21 YEARS, ADMITTED JUNE 30

Clinical history.—High fever, headache, and vomiting for two days. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—One day after administration of the drug blood smear became negative and temperature normal.

CASE 16. E., IGOROT, AGE 40 YEARS, ADMITTED JUNE 30

Clinical history.—Fever, headache, and chills every afternoon for three days. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Two days after administration of the drug temperature became normal and blood smear negative the 4th day.

CASE 17. S. D., AGE 24 YEARS, ADMITTED JULY 4

Clinical history.—Fever, headache, and chills for two days coming every afternoon. Spleen tender and palpable on deep inspiration.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Two days after administration of the drug temperature became normal and blood smear negative the 5th day. Spleen not palpable on day of discharge.

CASE 18. S. T., AGE 34 YEARS, ADMITTED JULY 5

Clinical history.—Fever, headache, and chills every afternoon for three days. Spleen palpable on deep inspiration.

Treatment.—Totaquina, 0.6 gram three times a day for seven days and then reduced to 0.3 gram t. i. d. until the 15th day.

Observation.—Three days after administration of the drug temperature became normal and blood smear negative the 5th day.

CASES OF MALIGNANT TYPE

Cases 19 to 21 were all diagnosed as subtertian malaria. Fever charts and results of blood-smear examinations are given in text fig. 1 and Table 1. Physical examination normal unless otherwise stated.

CASE 19. S. M., AGE 60 YEARS, ADMITTED JUNE 26

Clinical history.—Fever, headache, and chills, followed by profuse perspiration every afternoon for three days. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day for nineteen days, then reduced to 0.3 gram t. i. d. until discharged two days later.

Observation.—Two days after administration of the drug temperature became normal. Young asexual forms disappeared the 8th day, but gametocytes persisted until the 16th day of treatment, when plasmochin (1 tablet

t. i. d.) was added to totaquina. Gametocytes then disappeared in forty-eight hours.

CASE 20. J. B., AGE 25 YEARS, ADMITTED JUNE 29

Clinical history.—Fever, headache, and chilly sensation for six days every afternoon. Spleen not palpable.

Treatment.—Totaquina, 0.6 gram three times a day. After thirteen days' treatment there were still crescent forms in the peripheral blood. Plasmochin simplex then added to treatment, one tablet three times a day.

Observation.—One day after administration of the drug temperature became normal and young asexual forms disappeared the 6th day. Crescent forms appeared in increasing numbers. Two days after adding plasmochin to totaquina the blood smear became negative.

CASE 21. M. C., AGE 1 YEAR 5 MONTHS, ADMITTED JULY 6

Clinical history.—Fever occurring irregularly for about two weeks. Spleen extends to umbilicus.

Treatment.—Totaquina, 0.2 gram combined with lactose in papers administered with milk three times a day for fourteen days. The 7th day plasmochin was added, one tablet once a day for six days.

Observation.—Three days after administration of the drug, temperature became normal and asexual forms disappeared the 6th day. Crescents began to appear in increasing numbers. When plasmochin was added to treatment, gametocytes began to decrease in number and after four tablets were given, gametocytes were no longer seen.

COMMENTS

Totaquina in doses of 0.6 gram three times a day usually relieves the patient of symptoms within two days, at most three days. The temperature returns to normal and no more chills occur. The schizonts and gametocytes of benign tertian disappear within the same period, schizonts being cleared first.

The effect of totaquina on the crescent form of *Plasmodium falciparum* is negligible, just as in quinine or atabrine medication, but it is definite on schizonts of the malignant type. As was observed, addition of plasmochin to the treatment clears the blood of crescents. There were no untoward effects of totaquina observed, such as ringing in the ears, vertigo, vomiting, or deafness, frequently observed in intense quinine medication.

We observed that with administration of the drug there was a tendency toward increase in the number of gametocytes in subtertian cases. This has been observed also with quinine and atabrine. It appears that the response of parasites to the drug leads to increased formation of gametocytes.

Whether totaquina would give a thorough cure so as to prevent relapses, we are not yet in a position to say, as the period of ob-

servation after patients were discharged from the hospital was too short and the chances of reinfection were too many.

The fact that totaquina is much less bitter than quinine (although more bitter than euquinine) makes it easily administered to children.

SUMMARY

This paper briefly reviews the history of cinchona and its alkaloids, especially quinine. It points out that cinchona cultivation has been found practicable in the Philippines by the Bureau of Forestry. It calls attention to the recommendation of a committee of the Health Organization, League of Nations, that a standard extract of total alkaloids of cinchona be developed as a cheap substitute for the purified quinine. The name "totaquina" was recommended for this new product.

This paper reports the easy and inexpensive preparation of totaquina at the Bureau of Science from Philippine cinchona bark. It further reports successful clinical trials with totaquina at the Iwahig Penal Colony Hospital.

Finally, this paper suggests that the preparation and distribution of Philippine totaquina could be developed into a local industry of importance, and that it might have a notable effect in reducing the incidence of malaria.

CONCLUSIONS

1. It is not improbable that if every case of malaria occurring in one year in the Philippines could be given a 250-grain treatment there would be needed at least 30,000 kilograms more specific febrifuge than is now imported.

2. A 250-grain treatment with quinine sulphate in the provinces costs from 2.50 to 5 pesos (1.25 to 2.50 dollars United States currency). The greater the need, the higher the price. Quinine dihydrochloride retails for from two to four times as much as the sulphate. These retail prices are far more than the average farmer in the provinces can pay. Quinine and the synthetic drugs plasmochin and atabrine may therefore be called a rich man's remedies. There is no probability that much more quinine can be paid for than is now imported.

3. The Bureau of Forestry has demonstrated that cinchona will grow in the Philippines and will give as good a yield of alkaloids as that grown elsewhere.

4. From our studies we conclude that the standardized total-alkaloid-extract of cinchona, recommended by the Health Organ-

ization of the League of Nations and called "totaquina," can be prepared locally from Philippine cinchona easily and inexpensively.

5. We conclude from some clinical tests that this Philippine totaquina is probably about equal to quinine sulphate in its therapeutic value against malaria. We are not able to form any conclusion as regards relapses, but we found that totaquina subdues the acute attack effectively and without untoward effects. It does not destroy the crescents of subtertian malaria, being similar to quinine and atabrine in this respect.

6. We conclude that, allowing a fair profit to the grower of cinchona, the manufacturer of totaquina, and to the retailer, this Philippine totaquina could be sold to the people at not more than 35 centavos (0.175 dollar) per 250-grain treatment.

7. Contrasting 35 centavos with the present retail price of from 2.50 to 5 pesos for a 250-grain treatment with quinine sulphate or atabrine, we conclude that the local production of totaquina would materially aid in combating malaria in the Philippines.

8. We also conclude that the growing of cinchona and the manufacture of totaquina might have considerable economic importance to the Islands, being capable of becoming sizeable new industries.

DATA FURNISHED BY THE PHILIPPINE BUREAU OF FORESTRY

	Pesos.
Cost of 5,016 seedlings to be planted in 1 hectare with spacing of 1.5 by 1.5 meters at 11 pesos per 1,000	55.18
Average cost of clearing, preparing, and planting 1 hectare	114.00
Total	169.18
Interest due 169.18 pesos for seven years at 7 per cent, compounded annually	102.52
Annual expenses for up-keep and supervision, excluding land rent and taxes at 127 pesos per hectare, plus the interest on the amount at 7 per cent, compounded annually	1,099.46
Cost of harvesting and curing the bark of 2,721 trees at 0.10 centavos per tree	272.10
Total expenses	1,643.26
Yield of 2,721 trees at 0.96 kg per tree, 2,612 kg at 0.87 centavos per kg	2,272.53
Profit at the end of the seventh year	629.32
Income per hectare per year	89.90

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ILLUSTRATIONS

TEXT FIGURES

THE TECHNIC OF HANDLING MOSQUITOES[1]

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and

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EIGHT PLATES AND TWELVE TEXT FIGURES

INTRODUCTION

The authors have recently prepared a series of papers to facilitate the practical identification of Philippine *Anopheles*.(1, 2, 3) This discussion of technic is added to supplement those papers, in the hope that it will increase their usefulness. It is intended to be simple enough for ordinary field use in the Islands and yet sufficiently comprehensive to assist those who may desire to do more than merely identify a given larva or adult.

We have found the following references of particular value with regard to the technic of handling mosquitoes: Boyd,(4) Christophers,(5) and Gater.(6) Many other references could be given. Most general books on tropical medicine include a discussion of this subject.

We cannot resist stating at the very outset that, to be successful, an inspector or other officer interested in malaria requires not so much finesse in technic as curiosity, enthusiasm, and determination. Field work in malariology will not permit white collars or polished shoes. It is frequently arduous, dirty, and damp.

Furthermore, there are almost as many technical methods of dealing with mosquitoes as there are malariologists. We can only present those which have seemed best to us. They should

[1] This paper has been prepared as a part of the program of Malaria Investigations, a project which has been jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. The Bureau of Health has coöperated through the assignment of the junior author as chief field director.

be modified and improved to suit individual needs and not followed slavishly.

TECHNIC OF HANDLING OVA

Individual anopheline or aëdine mosquito eggs are so small that they are rarely found in natural breeding places. *Culex* mosquitoes lay their ova in rafts (text fig. 1), and these are easily seen floating on the surface of stagnant water; but *Anopheles* ova are usually deposited singly and escape detection (text fig. 2).

Ova for study may be obtained from gravid females. When first laid they are white, but they soon become black. They vary in length from 0.6 to 0.8 millimeter, and each species has definite morphological characters. For some countries keys to the *Anopheles* ova have been prepared. For example, in Europe six varieties of *A. maculipennis* have been identified by their

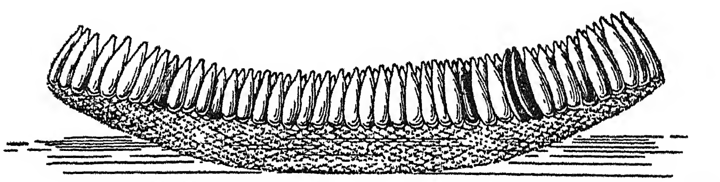

FIG. 1. *Culex* egg raft.

eggs.(7) It would be well to study the ova of Philippine *Anopheles*, a subject on which nothing has been published. Differentiation is made on the basis of size, shape, and position of the lateral floats, as well as the design on the dorsal surface of the ovum. Color may also be important. (See text fig. 2.)

According to Hackett(7) anophelines with ripe eggs will readily lay them in small cotton-stoppered vials, 50 by 20 millimeters, on wet filter paper or pressed cotton. "The eggs are usually laid in a small heap and they can be dispersed and at the same time preserved by dropping 2 per cent formalin on them from a pipette or dropping bottle (five or six drops). The eggs can be kept on wet cotton in small entomologist's tin specimen boxes, $1\frac{1}{4}$ in. in diameter, which have a glass set in the lid, through which the eggs can be examined. Washers or rubber rings cut from tubing the same diameter as the tin box serve to keep the cotton at the bottom from falling against the lid if the box should be overturned or sent by post." We have not tried this method.

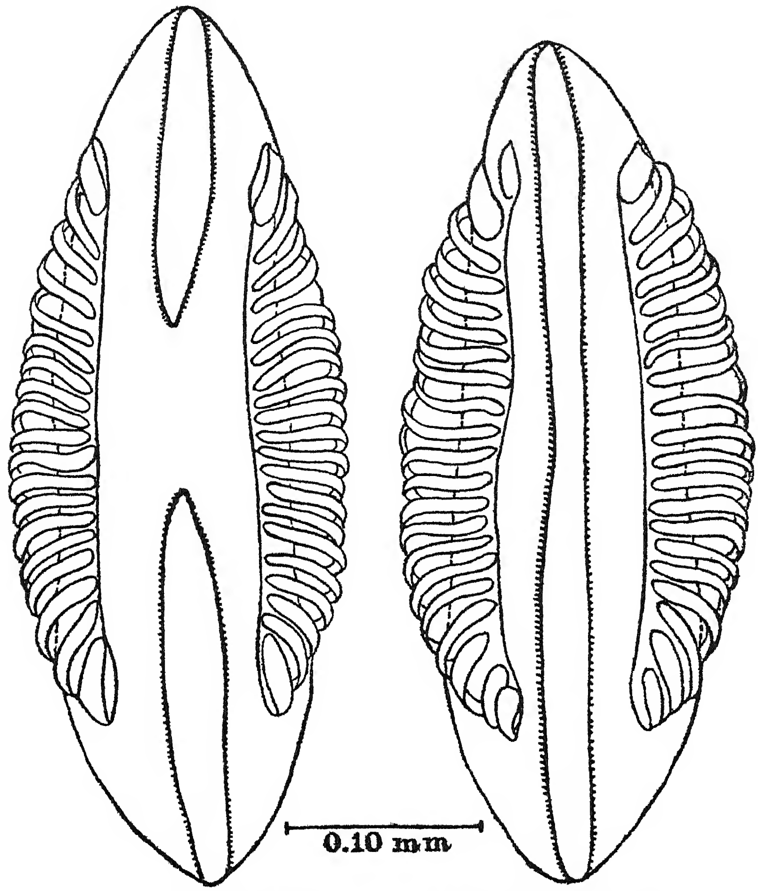

FIG. 2. Two types of eggs of *Anopheles minimus* var. *flavirostris*.

LARVÆ

COLLECTING LARVÆ (PLATE 1, FIGS. 1 AND 2)

The following equipment is essential for collecting mosquito larvæ:

1. Dipper.—Any sort of a receptacle may be used, from a coconut shell to a standardized copper dipper specially made for mosquito surveys. It is best as a rule to use a tin or enamel dipper having a long hollow handle into which a cane may be thrust. In some places a shallow pie tin or deeper cake tin may be useful. In other places, such as shallow water, a large spoon is most serviceable. If comparative quantitative studies are being made, a standardized dipper of about 400 cubic centimeters capacity should be used.

We have found very useful an Italian type of tin dipper having a screen window protected by an outer shell (text fig. 3). This screen permits water to be poured out of the dipper without loss of larvæ and thus facilitates the collection. If the inside of the dipper is painted white it is easier to see the larvæ.

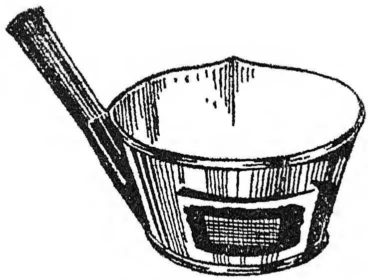

FIG. 3. Special type of dipper.

2. Pipette or spoon for removing larvæ from the dipper.—An ordinary medicine dropper with the narrow end cut off is satisfactory, although wider special collecting pipettes may be purchased and are more desirable. Narrow medicine droppers are not suitable for removing large culicine larvæ or pupæ, in fact these may be killed when drawn into the ordinary pipette. In such cases, if no large pipette is available it is better to use a spoon.

3. Collection bottle.—Some sort of a collection bottle is needed in which to carry the larvæ from the field to the laboratory. Any wide-mouthed bottle that can be stoppered will do. We have found half-pint mason jars satisfactory. These can be fastened to the belt.

4. Carrying case.—A carrying case is required for the bottles. We have used a simple wooden case with a rack to support six bottles upright (Plate 1, fig. 3). An army bag is useful in the mountains or difficult terrain. It can be slung over the shoulders or strapped to the back and permits the hands to remain unencumbered.

5. Notebook.—It is essential to keep an adequate record of the collections. A notebook and a pencil should be carried in the field so that notes can be made at the breeding place.

6. Bolo.—It is always wise to carry a bolo or other large knife to cut undergrowth and to kill snakes.

There are some practical points about larva collecting which should be noted. In the first place the type of breeding place to be searched is of importance. If the object of collecting is to make a complete anopheline and culicine survey, no accumulation of water can safely be overlooked. Even tree holes and miscellaneous rain-catching hollows and receptacles must be examined. *Aëdes mosquitoes* will breed in a gill of water, even within houses, as in ant guards and flower pots.

If only anophelines are wanted, the following types of breeding places may be included in the survey:

Running water in creeks, streams, rivers, ditches, canals, and springs.

Stagnant fresh water in wells, lakes, ponds, pools, ditches, and swamps, as well as in tree holes, rock pools, temporary rain puddles and hoof prints, and in miscellaneous barrels and tubs. Rice fields are a prolific source of *Anopheles* mosquitoes.

Salt water in salt ponds, fishponds, lagoons, swamps, and river mouths.

Finally, if the object is a malaria survey, collections may be limited to running water, including springs and spring-fed wells.

The proven malaria-carriers in the Philippines are *A. minimus* var. *flavirostris* and *A. maculatus*. The former is of paramount importance, while the latter has rarely been incriminated. Both species breed in running water, and neither has been taken in either salt water or completely stagnant water, except in fresh residual overflow pools in stream beds.

Anopheles minimus var. *flavirostris* is most abundant in foothill streams, close to partially shaded edges, especially where there are bamboo roots. It has not been found above 2,000 feet altitude. *Anopheles maculatus* has been taken up to 5,000 feet altitude. It is most abundant along the edges of partially shaded forest streams.

In collecting it is best to approach the actual breeding place without disturbing it, for the larvæ are easily alarmed and quickly submerge or scatter. They can remain submerged for several minutes. Therefore, while wading in the stream, the collector should try not to send waves toward the breeding place. If feasible, he should stand on the bank while dipping. The dipper should not hover over a breeding place but make decisive, clean-cut dips. It is to be remembered that the anopheline larvæ are on the surface, and surface water should therefore get into the dipper as expeditiously as possible. If dipping is done where there are roots, the dipper should be so manipulated that surface water will rush into it from among the roots, carrying with it the larvæ. It may be necessary to dip several times in one spot before the larvæ are taken.

In contrast to this "sucking" maneuver in which the water is drawn out from among roots, one may in some places use a sweeping movement of the dipper, skimming a considerable area

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of the surface of the breeding place in one arclike sweep. When there is débris or a floating log, the dipper may be quietly submerged beside it so that currents of water will carry the larvæ into the dipper, somewhat as in the case of larvæ from roots, described above. If the dipper overflows, many larvæ may be lost. If the water is turbid or full of débris, it may take several minutes to remove the larvæ from the dipper, as they are prone to remain for a time at the bottom. It is more difficult to take pupæ than larvæ, the former being quicker to see danger and to escape from it.

Small puddles and hoof prints may be stirred first, before dipping. The muddy water will furnish a background against which the larvæ, after a little time, are easily seen and removed directly with a pipette or spoon. For tree holes a long pipette is useful. One may easily be made from glass tubing and a large rubber bulb. If the tree hole is dry some of the material in the bottom should be taken. The ova of tree-hole mosquitoes resist drying, and sometimes, when the removed material is put in water in the laboratory, larvæ will appear.

For wells the dipper used by Russell and Santiago (8) is very useful. It has a long handle with a hinge and set screw near the dipper so that it may be given various angles to adapt it to existing circumstances.

The capture of only a few first-stage larvæ does not seriously incriminate a breeding place for it does not prove that larva will grow to maturity in the given site. But if large larvæ or pupæ are taken, or if larval skins are seen, then it may be assumed that the breeding place is of importance for the species taken.

If ten adequate dips along a meter of stream bank are fruitless, that site may safely be called negative at the time of examination.

Negative results may be due to inexperience in collecting, to recent disturbances, such as flushing, abrupt change in water level, agitation of the breeding place, application of larvicide, or to other causes. Therefore, a place found negative should not be omitted on subsequent visits, but subjected to repeated scrutiny.

Field notes should include not only the date and the general type of breeding place, such as stream, pool, or spring, but also a statement about shade—whether dense, medium, light, or absent. It is well also to record whether or not the water is clear or muddy, what type of bottom, what type of vegetation

is along the bank, what water plants are present, and whether natural enemies, such as top minnows or dragon-fly larvæ, are seen.

If quantitative studies are being made, the larva of different stages should be counted separately and the number of dips recorded. In all cases the place of collection should be carefully stated; that is, name of area, kilometer post, or distance and direction from a fixed, well-known point. If a detailed survey is being made it is essential to prepare a sketch map of the area, including roads, settlements, and bodies of water.

Finally, collecting larvæ successfully requires considerable practice. Many a place has been called negative because the would-be collector was not adept. The dry-foot man is never to be trusted because it is utterly impossible to make adequate collections without frequently entering the water. Experienced collectors sometimes rely on the appearance of a place and dip only in the likely places. This is dangerous, as one can be easily fooled. Larvæ are sometimes found in abnormal sites, especially in a dry season.

TRANSPORTING LARVÆ

Anopheline larvæ can be transported considerable distances, if reasonable care is exercised. We have found that the half-pint mason jars mentioned above are suitable. Several may be moved about in a wooden (not metal) collecting box which has a rack inside to keep the bottles upright, and a handle to facilitate carrying. If the distance to be covered is not great and the road is fairly smooth, the bottles may be two-thirds full of water with perhaps a small amount of green algæ added to minimize the motion of the water. If the larva must be transported over longer distances, it is well not to have the bottles more than a quarter full, and it is essential to add algæ. The bottles must be correctly labeled, and no natural enemies should be included in them. If jars are not available, bamboo joints may be used satisfactorily. They are especially useful for larvæ from rock holes and artificial containers. We have transported living larvæ in such bamboo joints from Mindanao to Manila, a four days' journey. A good number of *leucosphyrus* and near-*leucosphyrus* emerged from this collection. The top of the container was covered with gauze held in place by rubber bands.

Sometimes living larvæ may be sent through the mails in a special type of bottle, stoppered, but having a glass tube piercing the cork and extending about halfway into the bottle. The

quantity of water used is such that, no matter what the position of the bottle is, the surface of the water does not touch the open end of the tube (text fig. 4).

Boyd(4) states that for transportation over very rough ground or on horseback it is a good plan to transfer the larvæ to a bottle

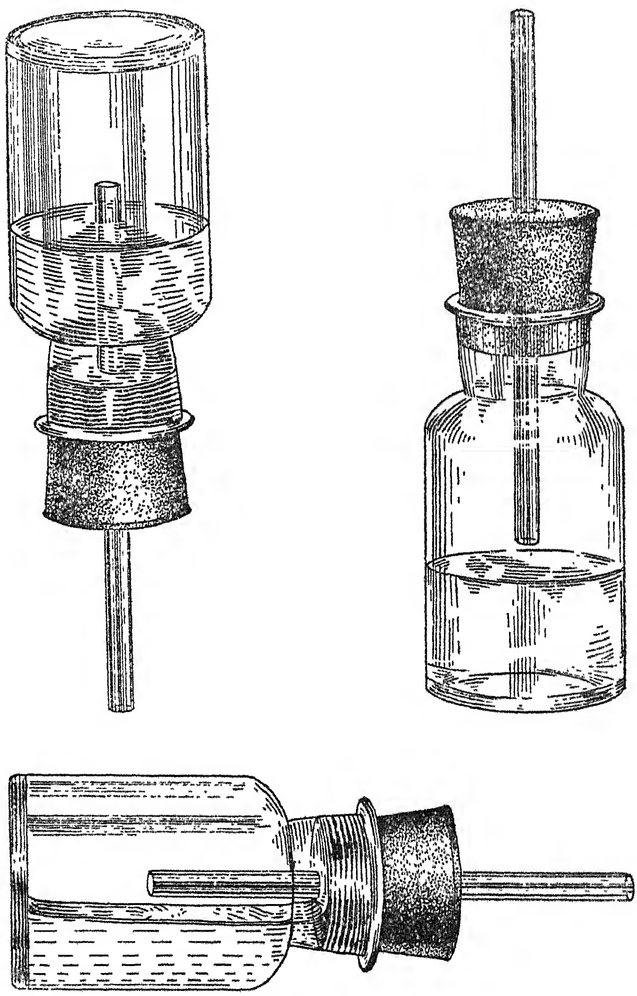

FIG. 4. Larva shipping bottle.

which has been freshly filled with water and emptied, so that the inside is wet. The larvæ become deposited nearly immobilized in the film of moisture and the surplus water is discarded. The bottle is then tightly sealed. A second bottle is filled with water from the breeding place, and this furnishes a supply to be used in the laboratory for rearing the larvæ.

REARING LARVÆ (PLATE 2, FIG. 2)

When the larvæ have been taken to the laboratory they should be transferred to properly numbered or labeled bowls or pans, which have more surface area than the bottles. Special attention must be paid to light, temperature, and food. For proper development the larvæ require some direct sunlight, but in the Tropics it is sufficient to expose them only from about 6 to 7 a. m. For the rest of the day it is better not to have them directly in the sun. An appreciable rise in the temperature of the water above normal will result in high mortality.

Numerous foods have been recommended for larvæ. We have found a mixture of Löffler's dehydrated blood serum and litmus milk satisfactory for all species of mosquito larvæ. Very small amounts are used. Another good food is yeast. A piece about half a centimeter square may be put in the bowl on a support of some kind so that the yeast is held about a centimeter or so below the surface of the water.

Where these special foods are not available good results may be had with natural algæ, finely chopped cockroaches, or hay infusion. The last is made simply by adding some hay or rice straw to water and allowing it to soak. Algæ from salt-water ponds, boiled and allowed to stand for a few days, form a white scum which is an excellent food for larvæ. It is somewhat odorous and should be protected by gauze from flies. Regardless of what food is used the water must not be allowed to get foul and should be changed as necessary.

It has seemed to us that aërating the water accelerates development of the larvæ. This is done simply by means of a pipette, repeatedly but gently injecting air below the surface of the water in the bowl.

It is sometimes a good plan to separate the various stages of larvæ, for the older may attack and devour the younger ones. Culicine larvæ should be kept separately as many species are cannibalistic. As a general rule, unless the species is a rare one, it is best to discard the small larvæ and to rear only those of the third and fourth stage. The smaller ones require much attention and give unsatisfactory results.

For rearing large numbers of *A. minimus* var. *flavirostris* larvæ Russell and Santiago (9) erected a wire cage in a stream at the bank. The water of the stream flowed through a very fine screen at each end of the cage, simulating natural conditions.

In the laboratory a flow of water through a basin may be secured from a receptacle used as a reservoir above the basin and connected with it by a thick thread of lampwick. This wick or thread extends from the water in the reservoir down to and through the basin containing the larvæ, and hangs over the edge of this basin. Water flows by capillary attraction and gravity down the thread to the basin and from there to waste.

It is necessary to inspect the bowls of larvæ each day. Pupæ are transferred to individual vials or test tubes about one-third full of water, and lightly plugged at the top with cotton. Pupæ do not feed, but are very susceptible to high temperatures and to rough handling. A small twig may be put in the vial or test tube as a resting place for the adult when it emerges. The vials or test tubes must be properly numbered or labeled.

Adults should be transferred to cages, lantern chimneys, or dry, clean vials, also properly labeled. Leaving them in the vial with water usually results in destruction of fringe spots and scales of the wings. But this transfer should not be made for about six hours, so that the adult will have time to dry out.

It is frequently a good plan to save the last skin, or pelt, which is molted when the larva becomes a pupa. This pelt is preserved, as noted below, and affords a very useful check on the identification when its identification is compared with that of the adult which emerges from the pupa. Making a diagnosis from both the larval skin and the adult avoids any possibility of confusion.

Each collector will by experience find out the best way to rear his larvæ under the conditions prevailing in his own laboratory. Surprisingly good results can be had with makeshift equipment, provided the collector has sufficient interest in the subject.

PRESERVING LARVÆ OR PUPÆ

It is always necessary to keep in mind the fact that the identification of larvæ or pupæ depends for the most part on minute body hairs. These are fragile and are easily rubbed off by rough handling. Therefore, the specimens must be handled with delicacy. It is a good rule to manipulate them singly and not to attempt to save time by carrying several in one manipulation of a pipette.

For temporary preservation the larvæ or pupæ may be killed in hot, but not boiling water (temperature about 65° C.). They may be transferred from the collecting bottle to the hot water and removed as soon as dead. Leaving them longer than neces-

sary in the hot water tends to bend the bodies and to make further examination or manipulation difficult. They may then be picked up by a pipette and put into a 10 per cent solution of acetic acid where they will retain their characters for a few days, at least. If chloral hydrate is available a more suitable temporary preservative is made by dissolving 57 grams of chloral hydrate in water and adding 6 cubic centimeters of glacial acetic acid and enough water to make 100 cubic centimeters of the preserving fluid.

Either of these temporary preserving fluids is suitable for forwarding specimens from the provinces to Manila, but neither is advisable for permanent preservation.

If permanent preservation of unmounted larvæ or pupæ is desired, MacGregor's solution is suitable. This is made by dissolving 5 grams of borax in water, and adding 2.5 cubic centimeters of glycerin, 100 cubic centimeters of a 40 per cent solution of formaldehyde, and enough distilled water to make 1 liter. After thorough mixing the solution is filtered. Larvæ or pupæ, after being killed in hot water, are placed in this solution, in small vials or bottles tightly corked and sealed with wax or paraffin. It is always wise to put a pencil-written label inside the vial and to add another label, written in India ink, on the outside of the vial. If this outside label is brushed with Bureau of Science book varnish it will be impervious to weathering and to cockroaches. We have found MacGregor's solution very satisfactory. It keeps the larvæ flexible, whereas in 10 per cent formalin they tend to become bent and somewhat brittle.

If considerable numbers of larvæ are to be preserved in one vial it is better to make a double transfer from water to a small beaker of the preservative and thence to a vial of fresh preservative. This prevents undue dilution. Larvæ and pupæ so mounted will keep their characters for many years, even under tropical conditions.

Larval pelts may be preserved temporarily in 70 per cent alcohol in individual vials, properly numbered. We prefer the borax-formalin solution described above. For permanent preservation it is best to mount the pelt, as described below.

MOUNTING LARVÆ OR PUPÆ

Larvæ and pupæ may be mounted for temporary or permanent use. Temporary mounts may be made of either living or preserved specimens. Living larvæ or pupæ may be mounted in a drop of water on a glass slide for diagnosis. If they are

handled with reasonable care they may be returned to the bowls and reared into adults. If it is necessary to use a cover slip on a living larva it is better to put a small piece of paper or broken cover glass, or a hair, under the slip to avoid injury to the specimen. The careful use of ice water or of weak chloroform water will tend to immobilize the larva without killing it.

Preserved larvæ may be mounted temporarily for examination in a drop of the preserving solution. It is usually better to use a cover slip and to mount the larvæ dorsum uppermost near the middle of the slide.

Permanent mounts give more satisfaction than the temporary ones. They may be made from either living or preserved larvæ or pupæ. We prefer Gater's(6) method of mounting. Based on his description the process for living larvæ is as follows:

1. Prepare the mounting fluid. This is done by placing 8 grams of picked gum arabic in 10 cubic centimeters of distilled water in a beaker which is covered and kept in a warm, but not hot, place, such as an incubator, stirring it occasionally until it is dissolved. After it has dissolved add 74 grams of chloral hydrate, stir and replace in incubator until dissolved. Then add 5 cubic centimeters of glucose syrup (98 grams of bacteriological glucose dissolved in 100 cubic centimeters distilled water) and 3 cubic centimeters glacial acetic acid. Stir and allow to stand. Then filter through No. 5 Whatman paper in a Buchner funnel, using a suction pump. If this is impossible, allow the solution to stand until all sediment has settled and then decant the upper portion. [If this solution cannot be made in a local laboratory a small supply may be obtained from the entomologist at the Bureau of Science or from the malaria control section of the Bureau of Health, Manila.]

2. Transfer the larva from the collecting bottle or rearing bowl to the center of a glass slide. We have found it a good plan to trace the outline of a standard slide on a piece of cardboard and on this trace the outline of a cover glass, marking the center. This furnishes a guide for mounting. The specimen should be placed with the head toward the one doing the mounting. A little practice will soon result in perfectly aligned slides so that there will be complete uniformity of appearance in a box of slide mounts.

3. Remove as much water as possible, first with a capillary pipette and then with a piece of blotting paper until the specimen is almost dry. Avoid touching the larva as much as possible. If it gets out of position it can be maneuvered into place by tapping and tilting the slide. Experienced technicians, however, can arrange and rearrange the larva and its hairs using very fine dissecting pins and a binocular to get the best results. Allow the larva to adhere to the glass so that it will remain in place during subsequent manipulations.

4. With a fine glass rod place a drop of the mounting medium, described in paragraph 1 above, over the larva as it lies with dorsal part of head and body uppermost. When the larva is dead add another drop

of mounting fluid and carefully place a clean cover glass over the specimen. The fluid decreases in volume as it dries so an excess should be used. This medium sets hard in about a week but the larva will be cleared and suitable for examination in a few hours.

Slightly better results may be had if the larva is killed in hot water and then kept overnight in the chloral hydrate medium described under temporary preservation above.

5. Add the proper label at the right end of the slide as the head of the specimen is towards the one doing the mounting. Brush the label with a collodion or book varnish to preserve it.

6. When the mounting medium is dry the cover glass should be ringed as neatly as possible with a cellulose varnish such as Duco. This is best done with a turntable but may be accomplished satisfactorily by hand.

Mounting larvæ which have been preserved is done in the same way as just described, except that, if MacGregor's solution is the preservative, it is advisable on removing the larva to place it first in water for an hour and then overnight in the chloral hydrate temporary solution described above. Larvæ which have been temporarily preserved in acetic acid may be directly mounted but are better if given a preliminary bath in this chloral hydrate solution.

The arrangement of the specimen on the slide so that the hairs are properly disposed requires a careful technic, which comes only after considerable practice. It is essential to use just the right amount of mounting fluid as larger or smaller drops will spoil the mounting. We have found satisfactory three drops from an ordinary toothpick when the smaller end of the pick is dipped for about one-third of its length into the fluid, and the initial drop is allowed to fall into the container as the toothpick is removed. Care should be taken that the fluid spreads evenly over the specimen which should be entirely submerged. The cover slip is dropped squarely on the top of the fluid.

The use of forceps in placing the cover glass may not be satisfactory as the glass may easily slip out of position. Thumb and forefinger are usually better tools.

Larval pelts may be mounted temporarily in a drop of the 70 per cent alcohol preservative. Permanent mounts of these pelts are extremely difficult and require considerable practice. Gater (6) gives detailed instructions which we are not including here as we suggest that, if permanent mounts are desired, the pelts be forwarded in the preserving fluid either to the entomologist of the Bureau of Science or to the malaria control section of the Bureau of Health, Manila.

IDENTIFYING LARVÆ AND PUPÆ

For the identification of the larvæ of Philippine *Anopheles* we have recently prepared a wall chart, distributed by the Bureau of Health, and an illustrated key,(2) which should be consulted. Other papers of importance in this regard are those by Manalang,(10) Baisas,(11) and King.(12) The pupal characters of Philippine species are being studied by the junior author.

Before attempting to identify a larva it is, of course, necessary to be acquainted with the larval characters used in a key. We have described this subject at length in our key.(2)

Having become familiar with the larval characters, one should proceed with the identification systematically. Head, thorax, and abdomen should be examined in order and the characteristics of the important hairs, the tergal plates, and the pecten noted. We prefer to use the low power of a compound microscope in the identification of larvæ. With a little practice it becomes possible to recognize all of the essential characters. One of us(13) has used a microscope mounted on a tripod by Darling. This was taken into the field and the species of larvæ in a given breeding place were identified at once.

When the characters have been studied it becomes possible, by means of the key, to make an identification; but usually more than one character is required for positive diagnosis. There are many individual variations. Furthermore, although Barber et al.,(14) Holt and Russell,(15) and Russell(16) have published fairly comprehensive reconnaissance studies, there has not been an adequate survey of Philippine *Anopheles*. Therefore, the possibility of encountering a new species or variety is always present. If a careful study of a specimen fails to establish a clear diagnosis, it should be sent to the malaria control section of the Bureau of Health.

DISSECTING LARVÆ

It is sometimes desirable to dissect larvæ to determine their diet or to observe whether or not they have ingested a larvicide mixture, such as Paris green and charcoal.

Apparently, most anopheline larvæ ingest a heterogeneous diet, consisting of any sort of inert or living material small enough for passage through their gullets; but their nutrition seems to depend on the digestion of such green algæ as *Euglena* and *Cosmarium*, diatoms, rotifers, ciliates, and other protozoa. No studies have been reported on the diet of Philippine *Anopheles* larvæ, although it is a matter of importance.

The dissection of a larva offers little difficulty. With dissecting needles the anterior part of the thorax is cut off. Then the abdomen is nicked just anterior to the last segment and the gut attached to this terminal segment drawn out. The gut is transparent, and if it is flattened in a drop of water or saline solution under a cover slip, such contents as Paris green, charcoal, or protozoa can readily be distinguished.

As noted by Boyd and Foot(17) the digestion of a larva proceeds very rapidly, and owing to the disturbance of the water in a collecting bottle the larva may not feed during transit. For this reason the gut may be nearly empty by the time the larva is examined in a laboratory. Therefore, the specimen for examination of gut contents should at the time of capture be put into a solution of 10 per cent formalin 9 parts, and glycerin 1 part. It is better to use only fourth-stage larvæ. Then, in the laboratory, after making an identification of species, the gut may be removed and crushed in a little water on a glass slide. Several specimens from larvæ of the same species may be put together and a microscopical analysis of the total gut contents made.

In larval food studies it is usual also to collect about a half pint of water from the breeding place, and, after shaking and centrifuging in the laboratory, to examine the sediment for plankton.

IMAGINES, OR ADULTS

COLLECTING ADULT MOSQUITOES

The following equipment is essential for collecting adult mosquitoes (Plate 3, figs. 1 to 3).

Flashlight.—Adult mosquitoes usually are caught either at night or in dark places in the daytime. Therefore, a flashlight is indispensable. An ordinary two- or three-cell dry-battery light is suitable. If the light can be focused it may be slightly more convenient, but this is not essential. A supply of batteries and bulbs should be available. Incidentally, as noted below, a powerful flashlight is very useful in the laboratory for the examination of adults.

Catching tube.—Many types of catching tubes are used. The simplest and the one which has given us good results is a small vial measuring about 8 by 1.5 centimeters. Test tubes may be used. With a little skill such a vial or tube can be placed over a resting anopheline and quickly corked with the disturbed insect inside. Only one insect should be kept in a vial.

Another very useful collecting tube is easily made by attaching a length of rubber tubing over one end of a glass tube. The tube should have a diameter of about 8 to 10 millimeters and a length of about 30 centimeters. The rubber tubing is about 45 centimeters long. The end of the glass tube over which the rubber is tied should be first covered by a piece of gauze. Suction is made by the mouth at the end of the rubber tubing as the free end of the glass is placed near a mosquito, which is easily sucked into the tube and then gently blown into a collecting vial or killing bottle. Large numbers of insects can be caught by this tube in a very short time. Even flying mosquitoes can sometimes be caught. This method is somewhat rougher than hand-catching with individual vials, but, with practice, it is satisfactory.

Various types of special catching tubes are sold by entomological supply houses. One which has had widespread use is a thick-walled, hollow, glass cylinder about 15 centimeters long and 3 centimeters in diameter. It has one inverted conical end which is perforated by a small hole. The other end is covered with a piece of gauze and corked. Through a hole in the cork there is a short glass tube on the outer end of which is a rubber suction bulb. Mosquitoes are sucked into this tube and cannot easily escape.

Carrying box or case to transport the insects to the laboratory.—Any suitable box or bag or even the collector's pockets may be used to carry the collecting vials or tubes of mosquitoes. It must be remembered that exposure to direct sunlight quickly kills mosquitoes, as does prolonged drying or jarring.

Notebook.—It is essential to label the catch properly and to keep a field record of the collecting places. If quantitative studies are being made, the length of time spent in searching should be recorded.

It is very unusual to catch *Anopheles* adults in, on, or under Filipino nipa houses in the daytime. These insects enter such houses freely at night and when blooded have been observed to linger inside until daybreak, but when it becomes light the *Anopheles* mosquitoes seek other daytime shelter. Nipa houses are light, dry, and airy, whereas the insect prefers to rest where it is dark, damp, and quiet. Typical daytime resting places for local anophelines are small undercut caves along stream banks, well-shaded mossy stone walls such as those near old churches or cemeteries, small sheltered cuts, or the interstices of the inner

wall of a shallow well, on the moist walls of partially covered cisterns, under cement structures, and sometimes inside strong-material houses in a dark, damp room. Adult anophelines may be caught by day or by night and will be discussed under these two headings.

DAYTIME CATCHES

Philippine *Anopheles* have a flight range of at least 2 kilometers. They are not active by day but only at night, and their daylight hours are spent quietly in such shelters as described above. Therefore, if daytime catches are to be made, typical shelters must be searched. This presents no difficulties, except that occasionally snakes will be found in the same small caves chosen by the mosquitoes. An efficient way to collect anophelines by day is to walk down a stream known to be a breeding place, methodically searching each undercut with a flashlight. Not only the stream-breeding species will be found, but also others from nearby rice fields and pools. If there are well-shaded old stone walls in the vicinity they may also be a fruitful source of anophelines.

Artificial daytime shelters can be made by lining boxes with moist earth. The earth-lined box traps that we have used measured about 1 by 0.5 by 0.5 meter.(21) The bottom and one end of the box are removed so that the floor of the trap is earth. With wire screening to hold it, a layer of moist earth about 1 inch thick is applied to the inside of the remaining three sides and the top. The open end is partly closed with a black cloth, which hangs to within 5 or 10 centimeters of the ground. This provides the insect with a dark, damp, quiet, and earthy resting place, such as it naturally seeks. Such traps may be placed near breeding places, under houses, or wherever it is desired to trap anophelines. The insects are easily taken with any of the usual collecting tubes, as they rest quietly on the inside.

NIGHTTIME CATCHES

Anophelines in the Philippines may be caught at night on the walls of bedrooms, on mosquito nets, or feeding on carabaos or cows. Many local species, including the malaria-carrying *A. minimus* var. *flavirostris,* will feed on carabaos, and can be easily caught while doing so. By the use of a fairly tame beast and a flashlight good catches can be made with any of the usual collecting tubes from about 7.30 p. m. until just before daylight.

We have had success with animal-baited traps. These are screened structures of various sizes, usually made somewhat larger than is necessary to accommodate one carabao. The carabao is tethered inside, surrounded by a bamboo railing to prevent damage to the screening. The one or two doors of the trap are left open but are closed just before daybreak. Many thousand anopheline mosquitoes have been taken daily inside such traps. It is wise to have an overhanging roof to protect the walls of the trap from rain, and to darken it somewhat so that the insects will not be too eager to escape at daybreak.

Smaller traps, baited with a man sleeping inside but under a mosquito net, have also given good results. In one case we used a screened room in a nipa house, closing the windows at daybreak.

The malaria-carrying *A. minimus* var. *flavirostris* apparently will take cow or carabao blood about as readily as it will take human blood, so that animal-baited traps are suitable even for this species.

Baited traps located in the center of a control zone will serve as useful indicators to measure the success or failure of control projects. If the malaria-carrying mosquito is taken in the trap in considerable numbers the control project is not succeeding.

If cattle were kept in sheds in the Philippines, such cattle sheds would doubtless be suitable places for catching adults, but we have rarely seen any sort of cattle shed in use locally. The usual shelters, if they exist at all, consist merely of a roof supported by posts, with no side walls. Strong-material houses attractive as daytime-resting places for mosquitoes are also the exception rather than the rule in the provinces.

Sometimes jungle species of *Anopheles* can be taken by sitting quietly in the dark in a suitable place, collecting those which attempt to feed. This is a dangerous procedure in malarious regions.

We have not had much success using collecting nets. Apparently the local species do not rest to any extent among grasses or shrubbery in the daytime. Occasionally it is possible to net considerable numbers of anophelines as they swarm beside a breeding place at dusk.

We have not been successful with any of the usual plain box traps reported in the literature. Only our earth-lined box trap mentioned above has given us good results.

It requires a little experience to detect adult mosquitoes as they rest in their natural sheltering places. One must look closely and carefully, but it is not long before practice makes it easy not only to see the insects but even to differentiate *Anopheles* from *Culex* and sometimes to identify immediately certain species.

TRANSPORTING ADULT MOSQUITOES

Whatever collecting tube is used it is necessary to have a box or a bag for transporting the insects to the laboratory. They must be kept out of the direct sun and should be handled as gently as possible. Various types of field transporting boxes have been used, and one may be easily devised to meet the needs. Wood is better than tin for a field box as it will not conduct heat so well.

We have had considerable success shipping living mosquitoes by mail in individual glass vials, packed carefully in a mailing container. The vials we have found best measure 8 by 1.5 centimeters. A hole is punched in the cork and a moist cotton plug is put in the hole. A strip of blotting paper is wedged inside along the length of the vial and a mat of the same substance is placed at the bottom. We have had a high percentage of success by this method, up to three days in transit by train and bus, with outside shade temperatures up to 37° C. (98.2° F.). As a matter of convenience the mosquitoes were caught and shipped in the same vials. After receipt in the laboratory the mosquitoes, still in their individual vials, if put in an ice box, will in many cases remain alive for a week (text fig. 5).

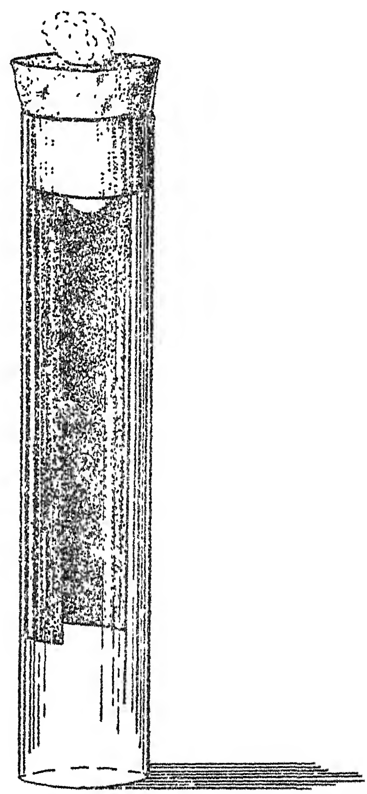

FIG. 5. Vial for shipping living adults.

We have had some success shipping live mosquitoes in a box patterned after Barraud's, but we have come to the conclu-

sion, after comparative tests, that the individual vial method is a better one.

Incidentally, if the mosquitoes being transported are from malarious regions, very great care must be exercised in opening the container which may contain deadly mosquitoes. It has been our practice to use a small screened cage having a cloth-sleeve entrance, so that both hands could be put inside the cage and any manipulation procedures carried on without danger of the mosquito escaping into the room. Of course, in many cases it will suffice to kill the insect in its vial by applying chloroform to the cotton plug in the cork, as soon as it is received in the laboratory.

The chief advantage in shipping mosquitoes alive is that they may be dissected in a central laboratory. It also facilitates studies of the ova.

If it is desired to ship dead mosquitoes they may easily be killed with chloroform vapor. Sufficient exposure should be allowed so that the insects are actually killed and not merely stupefied. They are then put in pill boxes, one collection to a box, unless there are so many that undue crowding would result. Ordinary cardboard pill boxes may be used. A still better box is the small 0.25- or 0.5-ounce tin container such as is used to gather samples of fæces for diagnosis, or to hold various ointments.

A little naphthalene, wrapped in a layer of cotton, is put in the bottom of the container. Lens paper is better. The insects are placed on top of the lens paper, or cotton, and are covered by another layer of the same material, and the tin or pill box is capped with its cover. Cotton expands and tends to put undue pressure on the specimens, so that if used it should be sparingly.

A minute drop of creosote may be used instead of naphthalene as a deterrent against ants and other insects, which quickly destroy unprotected specimens in the Tropics.

REARING ADULT ANOPHELINES (PLATE 2, FIG. 2; TEXT FIGS. 6 AND 7)

We have discussed the care of larvæ in the laboratory up to the emergence of the adult insect. The adults that have emerged in the pupal vials may be transferred to lantern chimneys, which serve well as cages. The smaller end is covered with gauze held in place by adhesive tape. The lower, larger end rests in a Petri dish, the bottom of which is covered with filter paper. Raisins, boiled with sugar, seem to make acceptable

food for the insects. One boiled raisin put on top of the gauze will remain succulent for a considerable time. Not more than 25 to 30 mosquitoes should be kept in one cage at a time. It

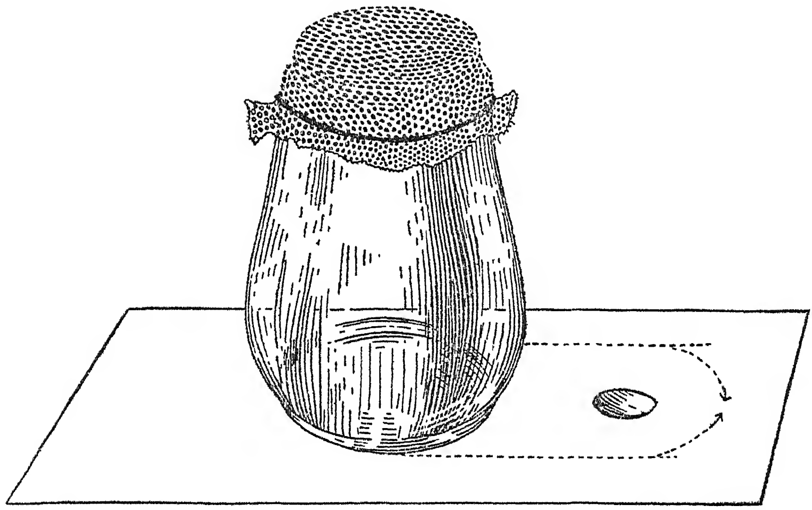

FIG. 6. Lantern-chimney cage with manipulating tin. Dotted lines show position of base of chimney when adults are being inserted or withdrawn.

is important to protect the cages from ants which can make serious inroads during a single night, destroying and carrying off the adults.

It is not necessary to use a lantern chimney. A small screened cage of any type can be used, provided food and water are

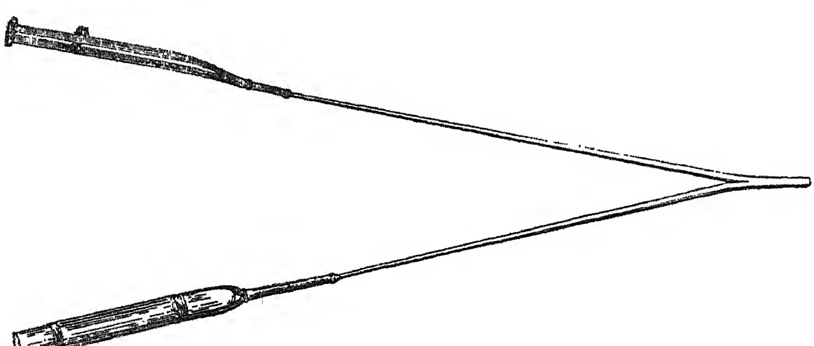

FIG. 7. Boyd's manipulating forceps for removing adults from cage.

supplied. The advantage of a lantern chimney is the ease of handling it.

Boyd (22) has devised a test tube on forceps, which facilitates the transfer of mosquitoes from cage to cage (text fig. 7). If

this mounted tube is used, the bottom of the chimney is covered with two pieces of rubber dam, or bathing cap. Each piece has a small slit in the middle and the two pieces are put together so that the slits are at right angles. This forms a valve opening through which the tube can be pushed to accomplish the removal or introduction of an insect. When the tube is withdrawn the valvelike slits close, preventing escape of mosquitoes from the chimney.

Two flat pieces of tin or of cardboard, each with a hole near one end, may be of use in transferring insects from one chimney to another. They should be large enough, so that when part of the tin or cardboard is completely covering the base of the chimney, the end with the hole projects beyond. The gauze covering of the chimney is loosened and the chimney placed on the unperforated end of the piece of tin. The gauze can then be pulled away, the tin blocking the escape of the insects. The same procedure is followed for the other chimney. Then the two chimneys are placed end to end with the two pieces of tin intervening. By sliding these pieces of metal, the holes can be brought into apposition and the insects driven from one cage to the other. Such tins can also be used in transferring insects from a vial to a chimney, the vial being pushed through the hole (which should have a diameter only slightly larger than that of the vial). To replace the gauze, the chimney with its temporary tin bottom cover is placed on the flattened gauze. Then the tin is pulled away and the gauze fastened in place as before. With a little practice one becomes adept at manipulating the living insects.

Aëdes mosquitoes will mate in lantern chimneys, and it is relatively easy to propagate a colony in the laboratory. *Culex* mosquitoes require somewhat larger cages and can be propagated without much difficulty in cages measuring 1 by 0.5 by 0.5 meter, but it is more difficult to propagate anophelines in captivity. The most successful experiments have been made by Boyd.(23) Occasionally in the Tropics freshly hatched anophelines will mate in a small cage, and viable eggs will result; but this is exceptional. Apparently a very large cage with carefully controlled water and food supplies is required. The cage should be large enough to accommodate a carabao or even several animals and some nearly natural breeding places, such as a section of a stream, or a small pool. We have not had success in colonizing anophelines in captivity in the Philippines in a cage measuring about 6 by 6 by 10 meters.

To obtain eggs for study, fully gravid females should be selected and placed in a small cage, such as an oil cylinder glass or a lantern chimney, over water. Christophers(5) suggests floating in the water a large but thin paraffin-coated cork ring slightly smaller in circumference than the water container and held up by the meniscus. This greatly facilitates the microscopical examination of the ova in situ. A piece of paper or a stick in the cage will give the mosquito a foothold. (See also above under the discussion of ova.)

PRESERVING AND MOUNTING ADULT ANOPHELINES (PLATE 6, FIG 2; TEXT FIG. 8)

There are many ways of preserving and mounting adult anophelines. The following account closely follows Boyd.(4)

Unmounted material can be kept either in the original pill boxes or transferred to test tubes. The former should be stowed in tight tin boxes, in which is kept a small dish of naphthalene and phenol to guard against insects and molds. If test tubes are used, they are prepared by pouring about 1 cubic centimeter of melted naphthalene into the bottom. This is covered by a small pledget of cotton. A layer of five or six mosquitoes is loosely arranged on this cotton, then another pledget of cotton is added, care being taken not to crush, but only to secure, the first mosquitoes. Alternate layers of mosquitoes and cotton are inserted until the tube is filled.

FIG. 8. One method of mounting an adult mosquito inside a glass vial.

Specimens which have been stored and are dry may be pinned for mounting if they are first softened. Several layers of moistened filter paper are placed in the bottom of a dish having a tightly fitting cover. The dried mosquitoes are spread on this paper and the cover replaced. After a few hours the insects can be mounted with little danger of breaking the appendages.

Pinned mounts are best made with freshly killed anophelines. When the mosquitoes are first exposed to chloroform vapor, the wings temporarily expand to a position at right angles to the body. MacGregor recommends that they be pinned immediately

upon becoming stupefied, thereafter being returned to the chloroform vapor until killed. Very fine pins 0.5 inch long, known by the German name "Minutenadeln," are best for insertion in the mosquito. These are without heads. Two methods of pinning may be followed.

(1) Expose the ventral surface of the specimen, grasp a pin with the pinning forceps, and insert the pin point into the ventral thoracic wall between the legs, gently pushing until the point just emerges from the dorsum of the thorax. With the pin still grasped by forceps, its base is forced into and put through a small oblong piece of pith or cork near one end of the latter. A No. 2 full-length mounting pin is forced through the opposite end of the piece of pith or cork, until the latter is fixed at about the middle of the pin. The mounted specimens are best preserved in small vials, a separate vial being devoted to each mounted specimen. The heavy pin of the mount is forced into the inner surface of the stopper, in a slightly eccentric location. These vials are of clear, thin glass, with no constriction at the neck. A good size measures two inches in length by one inch in diameter. The label of the specimen may be transfixed by the mounting pin before its insertion into the stopper, or pasted on the outside of the vial. The stoppers may be horizontally perforated about 3 mm. above the bottom, by a hole about three-eighths of an inch in diameter into which is poured melted naphthalene and phenol, which will quickly harden.

(2) Using slightly heavier and full-length pins from which the head has been snipped, the insect may be pinned by thrusting the point transversely through the thorax, then thrusting the cut end of the pin into the vial stopper. By this method the thoracic scales receive less damage. The vials are conveniently stored in pasteboard boxes divided into compartments, each compartment holding one vial.

Less valuable specimens may be pinned in ordinary insect-proof boxes, in which, however, they cannot be as readily examined.

Pinned specimens are not adapted to shipment through the mails. For this purpose specimens are best sent confined between layers of cotton in pasteboard pill boxes, a number of which can be shipped in a cylindrical mailing carton.

A good deal of trouble has arisen in the Tropics from oxidizing pins. The ordinary pins rust quickly. Silvered pins corrode in time and spoil the specimen. Nickel pins are best, but even these have not always proven satisfactory. It is now possible to buy stainless steel pins, but we have not yet tried these.

In our experience we have had good results putting no pin at all through the insect. We fasten the specimens by a very small drop of shellac to the tip of a small wedge of cardboard. This small piece of cardboard is then fastened to the cork with a No. 2 pin. The shellac is placed on the tip of the cardboard wedge, which is then carefully placed in contact with the

right side of the mosquito, which lies on its left side. To insure good adhesion the left side of the insect may then be pressed gently and carefully with a dissecting needle. This procedure, with a little practice, does no damage to important scales or bristles. It is possible to buy punches for cutting the cardboard wedges, but ordinary scissors may be used if necessary. Fairly long wedges are desirable when the insects are to be examined under high magnification. Practice is required in order to avoid damage to scales, wings, and legs, but when perfected the method gives excellent exposure for examination and the specimen does not deteriorate so rapidly as when pinned.

IDENTIFYING ANOPHELINE ADULTS

We have prepared and distributed a wall-chart key to the adult anophelines of the Philippines and have also presented a paper on the same subject. (3) The latter contains full descriptions of each species and also a discussion of the characters used for diagnosis.

A lens is required for the study of the specimens. A binocular entomological microscope is best, but an ordinary low-power monocular microscope can be used. In fact a strong doublet hand lens may be all that is required, although it will not give such good results as a microscope.

The examination can be made in reflected daylight or under artificial light. We have had good results using a focusing flashlight with three or four dry cells. This gives a powerful light which brings the bristles and scales into good relief. The light can be easily directed at any angle and does not give off as much heat as the ordinary microscope lamps (Plate 6, fig. 1).

With the specimen in good light under the microscope, the examiner must first be sure that it is a mosquito, and then, having decided that it is or is not an anopheline, note the sex. These three initial diagnoses are fundamental, and the following practical notes may be helpful:

HOW TO RECOGNIZE THE SPECIMEN AS A MOSQUITO

The following indicates that the place of mosquitoes among the insects is as follows: Phylum Insecta; order Diptera; suborder Nematocera; family Culicidæ; subfamily 1. Dixinæ; subfamily 2. Chaoborinæ; subfamily 3. Culicinæ (the true mosquitoes).

The word "diptera" is from the Greek meaning "with two wings." Therefore, the first criterion is that the specimen has two wings (and six legs).

The word "nematocera" is from the Greek meaning, loosely, "threadlike antenna." The Nematocera are small midgelike flies, with well-differentiated head, thorax, and abdomen, the last clearly segmented. The head bears two threadlike antennæ, which have from six to sixteen segments and are usually covered with fine, long hairs.

Next, to separate the Culicidæ from the other families in the Nematocera we note that all Culicidæ have a proboscis, long or short, and (except the Dixinæ) all have a dense fringe of scales which project backward along the posterior margin of the wings. Moreover, the delicate membranous wings always carry a complete venation as shown in text fig. 3 of our key.(3) If a given specimen does not have the posterior fringe of wing scales and the typical venation, it is not a mosquito.

Finally, to separate the subfamily Culicinæ, or true mosquitoes, from the other Culicidæ, note that all Culicinæ, or mosquitoes, have a long proboscis, which about equals the combined length of the head and the thorax.

HOW TO RECOGNIZE AN ANOPHELINE MOSQUITO

The Culicinæ are divided into three tribes; namely, Anophelini, Megarhinini, and Culicini. Edwards(24) gives the following key to these tribes:

Key to the tribes of Culicinæ.

1. Abdomen without scales, or at least with the sternites largely bare. Anophelini.
   Abdomen with both tergites and sternites completely clothed with scales. 2.
2. Proboscis rigid, outer half more slender and bent backwards. Megarhinini.
   Probscis more flexible, of uniform thickness (unless swollen at tip), outer half not bent.......... Culicini.

In our key to local adult anophelines we have mentioned other characters that may be of assistance in separating the tribe Anophelini.

HOW TO IDENTIFY THE SEX

Most male mosquitoes can be recognized at once by their "whiskered" appearance. Their antennæ have many long hairs, which give a distinctly plumed appearance easily noted at a glance. The female antennæ are sparsely ornamented. There are a few mosquitoes (none of the Philippine *Anopheles*) in which the male and the female antennæ are similar. The ques-

tion can always be settled by examination of the terminalia or the tip of the abdomen under a strong hand lens.

The male terminalia have a somewhat broadened appearance. There are two conspicuous hooklike claspers which cannot be mistaken. The female genitalia are not conspicuous. The tip of the abdomen is more pointed and there are seen two small papillæ, called cerci, which project either vertically or longitudinally (text fig. 9).

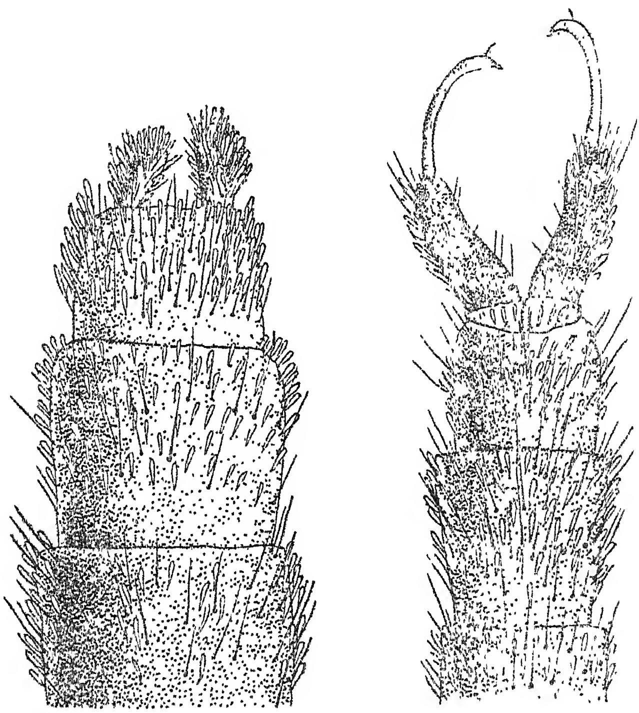

FIG. 9. Tip of abdomen of anopheline adults, male on right, female on left, showing distinctive characters.

Once the specimen in question is known to be an anopheline mosquito, it may be examined systematically with our key (3) at hand. When by means of the key a probable diagnosis of species is arrived at, the descriptive text referring to that species may be consulted to check in detail the various characters. When the drawings given in the corresponding plate are consulted, in most cases there will remain no doubt as to the identification of the specimen.

In all doubtful cases the specimen should be sent to the Health Service or to the Bureau of Science for further study, together with as many details about habitat as possible. Dried mounted

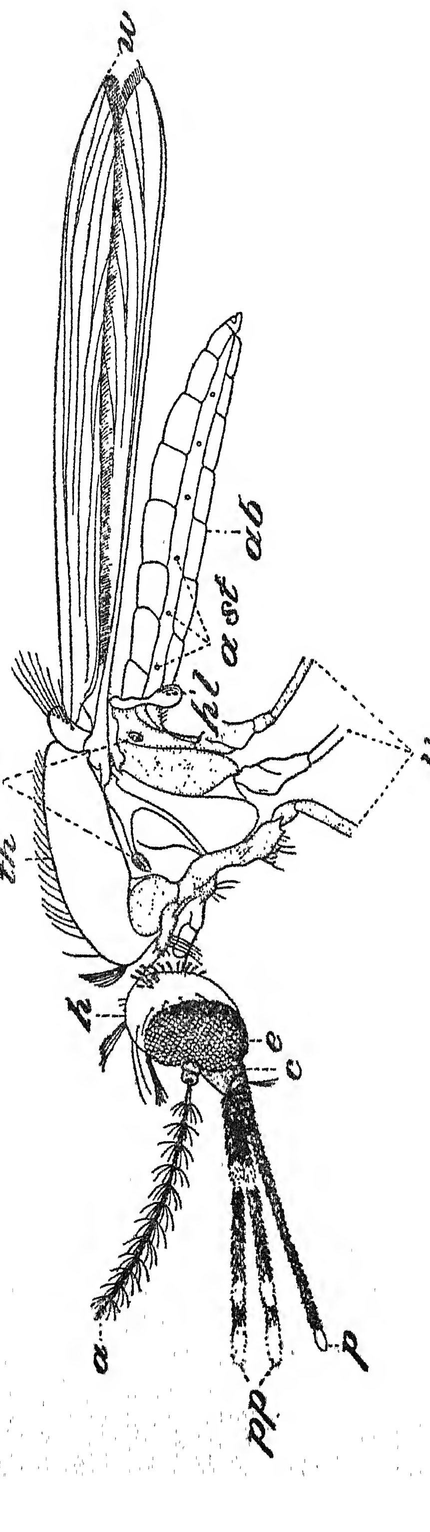

FIG. 10. Adult mosquito, showing, *p*, proboscis; *pp*, palps; *a*, antenna; *c*, clypeus; *e*, eye; *h*, head; *hl*, haltere; *th*, thorax; *tst*, thoracic stigmas; *ab*. abdomen; *ast*, abdominal stigmata; *w*, wings; *ll*, stumps of legs. (After Nuttall and Shipley.)

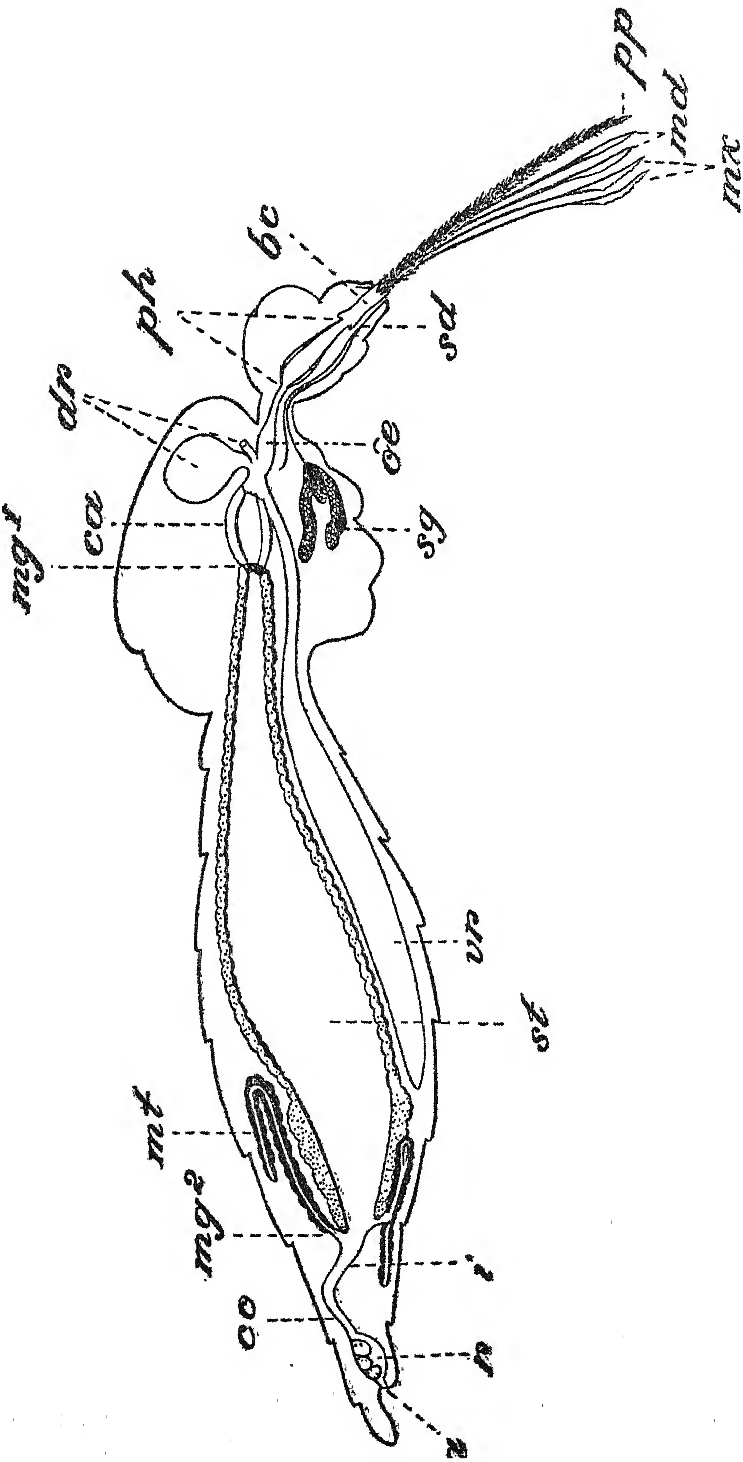

FIG. 11. Gross internal anatomy of mosquito, showing, *pp*, palp; *md*, mandibles; *mx*, maxillæ; *bc*, buccal cavity; *ph*, pharnyx; *sd*, salivary duct; *œ*, œsophagus; *sg*, salivary glands; *dr*, dorsal reservoirs; *vr*, ventral reservoir; *ca*, cæca; mg^1, midgut begins; mg^2, midgut ends; *st*, stomach; *mt*, Malpighian tube; *i*, ileum; *co*, colon; *r*, rectum; *a*, anus. (After Nuttall and Shipley.)

mosquitoes usually do not have their abdomen in the right position for examination. In such cases the entire abdomen is cut off and heated, first in a 10 per cent potassium hydroxide solution, and subsequently in distilled water. This process renders the organ in excellent condition for examination. The hairs and scales are not removed, the whole abdomen is transparent, and even the color of the scales is retained. For future reference such specimens may be preserved in formalin-borax solution or weak alcohol, and kept in a properly labeled small vial.

DISSECTING ADULT MOSQUITOES (TEXT FIG. 12)

Gut.—There are many ways of dissecting out the gut of a mosquito, and each technician has his own ideas as to which is best. The following description is based on Boyd's (4) directions.

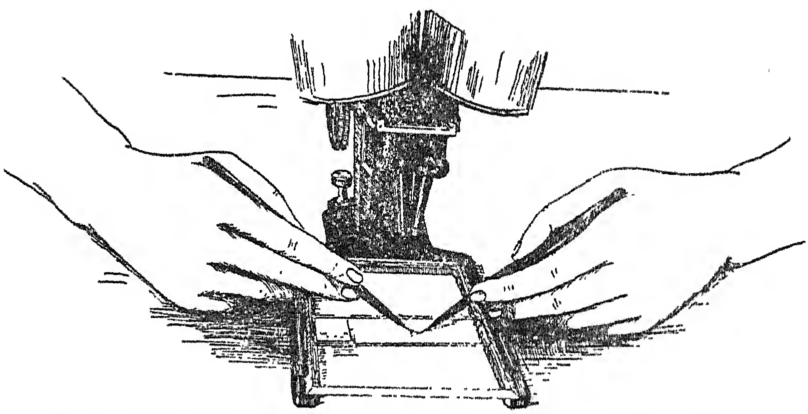

FIG. 12. Position of microscope, hands, slide, needles, and insect during dissection.

The specimens to be dissected are killed one at a time as needed, with the use of chloroform vapor. It is much better not to attempt to use those that have a gut distended with blood, but to dissect only those that have fully digested their last blood meal. Careful note should be taken of the species, as this is very important. In the Philippines, so far, only *A. minimus* var. *flavirostris* and *A. maculatus* have been found infected in nature. While the insect is held with forceps, which grasp the palps and proboscis, the wings and legs are cut off close to the body.

The mosquito is placed on a glass slide in a drop of physiological saline solution, which has been deeply tinted with methylene blue, and arranged with dissecting needless so that the dorsum of the insect is away from the dissector and the tip of the

abdomen at the right. Under a low-power lens the insect is held firmly by means of the straight needle thrust into the thorax near the abdomen. With the curved needle cuts are made into the seventh or eighth abdominal segment, both dorsally and ventrally. Then the last segment of the abdomen is transfixed with the tip of the curved needle, and the viscera attached to this abdominal tip are drawn out. The foregut usually breaks, and it is easy to draw out the viscera into the saline solution. (Some dissectors prefer to cut the abdomen away from the thorax before dissecting out the gut.)

The body of the mosquito is put to one side and the gut cleaned by gently cutting off the Malpighian tubes and other structures posterior to them. The clean gut or "stomach" is transferred by means of the needle to a drop of untinted saline solution on a clean slide and protected by a cover slip. The slide is gently heated over an alcohol lamp so that the heat will expand the gases inside the gut and so extend the walls, making them thinner.

The preparation should next be searched under high power for oöcysts. These cysts vary in size from about 6 to 50 microns. They are approximately spherical and appear a little more opaque than the gut cells. Because they are attached to the stomach wall they are usually distinct from yeast cells or similar bodies contained within the cavity of the stomach. One of the most useful criteria for the diagnosis of an oöcyst is the clump or chain of brown or black pigment granules which are always present in all but the very large oöcysts. These very large cysts are mature and striated with innumerable sporozoites. Such large cysts may be ruptured by slight pressure and the sporozoites, as they escape, are recognized by their morphology, as noted below. A small cyst should never be diagnosed as a malarial oöcyst unless it is definitely pigmented and is seen to be attached to the stomach wall. Sometimes, if the stomach is rolled a little, by pressing a needle on the cover slip, a doubtful body may be seen not to be attached to the wall.

Fat droplets and immature ova on or under the stomach, yeast cells in the stomach cavity, and occasionally other bodies may simulate oöcysts; but if the cyst is definitely attached to the stomach wall, and if it certainly contains either pigment granules or recognizable sporozoites, there can be little confusion. Small oöcysts up to 7 or 8 μ have no definite cyst wall. A single stomach may show from one to more than one hundred oöcysts (Plate 7).

Salivary glands.—What remains of the mosquito from which the gut was dissected should be turned so that the head and thorax project towards the right. The specimen is held in place by transfixing the posterior part of the thorax with the straight needle held in the left hand and the head carefully cut off with one clean, quick cut with an edged needle. The dull side of a needle held in the right hand is pressed gently on the middle of the thorax, forcing a small amount of tissue out at the neck end. Under a lens this tissue is cut off and gently teased apart, the examiner being alert to recognize the two blue-stained and trilobed salivary glands, which will show up clearly among the unstained muscle fibers. Then the glands are transferred to a drop of untinted saline solution on a clean slide, covered with a cover glass, and examined for sporozoites (Plate 8, figs. 1 and 2).

The thin fusiform sporozoites are usually easily recognized. They are either straight or slightly curved and average 12 to 14 μ in length. When alive they have a slow, sinuous movement. They must be distinguished from such artifacts as rod-shaped bacilli or crystals. It is always a good plan to stain them with Wright's or Giemsa's stain. Each sporozoite will show blue or violet cytoplasm and red chromatin. To stain, the cover is carefully lifted and inverted on a dry slide on a tiny drop of balsam. The balsam holds the cover slip in position while the preparation is dried, fixed, and stained. For description and methods of preserving these glands, see Manalang.(25, 26)

It is quite possible to dissect out the glands quickly and easily simply by cutting off the head, as the mosquito lies on its side in a drop of saline solution, and pressing gently on the pleura of the thorax, expressing the glands, often well isolated. It is not even necessary to remove the legs or wings, after a little practice. We have had good results by this simple technic when we have had many specimens to examine in a short time. But much better preparations are secured by the method outlined above.

Salivary-gland dissections may be dried on the slide, fixed, and subsequently stained with Wright's or Giemsa's stain, and sent to a central laboratory for confirmation of diagnosis.

The dissection of salivary glands of *Culex* mosquitoes is more difficult and requires additional practice.

Terminalia.—The dissection and preparation of the male terminalia are not easy and require a great deal of practice.

After the terminal segment has been cut off it is heated in a 10 per cent solution of potassium hydroxide. Care is taken not to heat it beyond the first steaming point, the correct temperature being about 60° C., such that the finger can just bear to touch the dish. Overheating makes such delicate parts as the leaflets of the phallosome very transparent so that it cannot be determined whether the thinner edges are serrated or not.

The phallosome is severed from its basal connections with the coxites, the theca is cut short, after which the apical portion, together with the leaflets, is transferred to a clean slide, with a tiny drop of Gater's fluid. The material is carefully immersed in the fluid and watched through a binocular while a cover slip is put in place. With a stout needle the cover glass is pressed down firmly when the phallosome is in the right position. The pressure helps to spread the leaflets nicely on either side without the need of cutting the theca into two longitudinal halves. The mounting fluid should be so little as to spread barely to the edges of the cover slip when pressed. Additional fluid may be added to make up the shrinkage after drying. Care should be exercised to use perfectly flat cover slips, as those which are a little convex spoil the best dissections by not staying in position when pressure is removed.

The isolation of the harpago is best done by pressing the outer side of the coxite with a needle directed inwardly at an angle of about 45°. This tilts the coxite a little and exposes the harpago to the best advantage for dissection.

SUMMARY

The technic of handling mosquitoes requires patience and practice, but it is not, after all, very difficult. It is essential that one have available a small library. If funds are limited, we should suggest as a minimum the following list:

Handbooks: Boyd's Malariology (4) and MacGregor's Mosquito Surveys. (27) Reprints: King, (12, a, b, c) Manalang, (10, 25, 26) and Russell and Baisas. (1, 2, 3) Wall charts: Key to Larvæ of Philippine Anopheles and Key to Adult Philippine Anopheles, published by Malaria Investigations and obtainable through the Bureau of Health.

The investigation of Philippine mosquitoes is a matter of importance, and so little has been done that it is a fruitful field for research.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Collecting larvæ, using dipper on the end of a rattan cane, making wide sweeps of surface water.

2. Collecting larvæ, dipper being pushed against a bank so that water flows into it from among the roots of the vegetation.
3. Carrying case for larva-collecting bottles.

PLATE 2

FIG. 1. Larva-collecting outfit. Three types of dipper, strong rattan cane, collecting pipettes, half-pint collecting bottles, knapsack carrying case, and rubber boots.

2. Rearing outfit for larvæ. Collecting bottle, enamel pans, glassware, pupal tubes, and pipettes.

PLATE 3

FIG. 1. Collecting adults. Showing a typical *Anopheles minimus* var. *flavirostris* breeding place and a collector using glass and rubber tubing, taking adults from a daytime shelter in small caves formed by an undercut stream bank.

2. Collecting adults with a glass-and-rubber, suction, catching tube. Natural daytime shelter.
3. Catching adults with a small vial. Natural daytime shelter.

PLATE 4

FIG. 1. Anopheles adult trap, at Iwahig, suitable for carabao bait, distant view.

2. *Anopheles* adult trap suitable for carabao bait, near view.
3. Earth-lined *Anopheles* adult trap, with cover held up.

PLATE 5

FIG. 1. Catching of adult *Anopheles* on carabaos at night. (Photograph taken in daytime.)

2. Lantern chimney, tin cover for transferring mosquitoes, and wire cage with cloth-sleeve entrance. Adults that may be infected are transferred from vials to lantern-chimney cage inside this larger cage.

PLATE 6

FIG. 1. Flashlight used as a source of illumination for the examination of adult mosquitoes. Method of placing a specimen for examination and the type of binocular microscope suitable for this purpose. A simple stand to hold the flashlight can easily be made.

2. Method of mounting an adult mosquito in a small drop of shellac, as explained in the text.

PLATE 7

Numerous oöcysts of malaria on the stomach wall of *Anopheles minimus* var. *flavirostris*.

PLATE 8

FIG. 1. A mature oöcyst under higher magnification, showing sporozoites. [From Manalang.(25)]

2. Sporozoites from a ruptured salivary gland; × 1,000. Stained. [From Manalang.(25)]

3. Sporozoites from a ruptured salivary gland, in saline solution; × 1,000. Unstained. [From Manalang.(26)]

TEXT FIGURES

FIG. 1. *Culex* egg raft.

2. Two types of eggs of *Anopheles minimus* var. *flavirostris*. (Drawn by Andres Nono.)

3. Special type of dipper.

4. Larva shipping bottle.

5. Vial for shipping living adults.

6. Lantern-chimney cage with manipulating tin. Dotted lines show position of base of chimney when adults are being inserted or withdrawn.

7. Boyd's manipulating forceps for removing adults from cage.

8. One method of mounting an adult mosquito inside a glass vial.

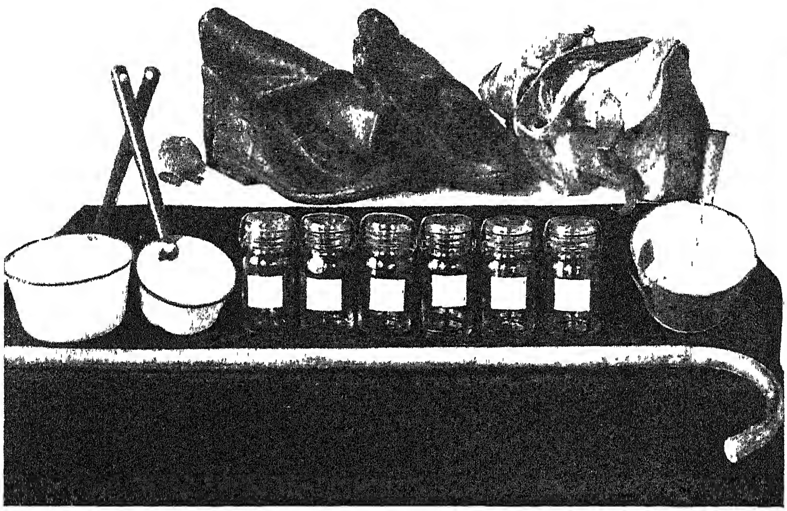
9. Tip of abdomen of anopheline adults, male on right, female on left, showing distinctive characters.

10. Adult mosquito, showing, *p*, proboscis; *pp*, palps; *a*, antenna, *c*, clypeus; *e*, eye; *h*, head; *hl*, haltere; *th*, thorax; *tst*, thoracic stigmas; *ab*, abdomen; *ast*, abdominal stigmata; *w*, wings; *ll*, stumps of legs. (After Nuttall and Shipley.)

11. Gross internal anatomy of mosquito, showing, *pp*, palp; *md*, mandibles; *mx*, maxillæ; *bc*, buccal cavity; *ph*, pharynx; *sd*, salivary duct; *œ*, œsophagus; *sg*, salivary glands; *dr*, dorsal reservoirs; *vr*, ventral reservoir; *ca*, cæca; mg^1, midgut begins; mg^2, midgut ends; *st*, stomach; *mt*, Malpighian tube; *i*, ileum; *co*, colon; *r*, rectum; *a*, anus. (After Nuttall and Shipley.)

12. Position of microscope, hands, slide, needles, and insect during dissection.

PLATE 1.



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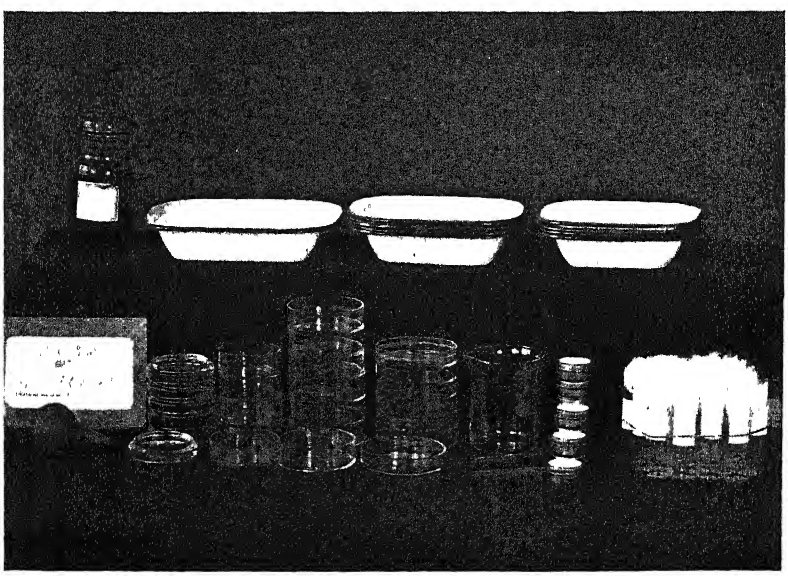

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PLATE 2.

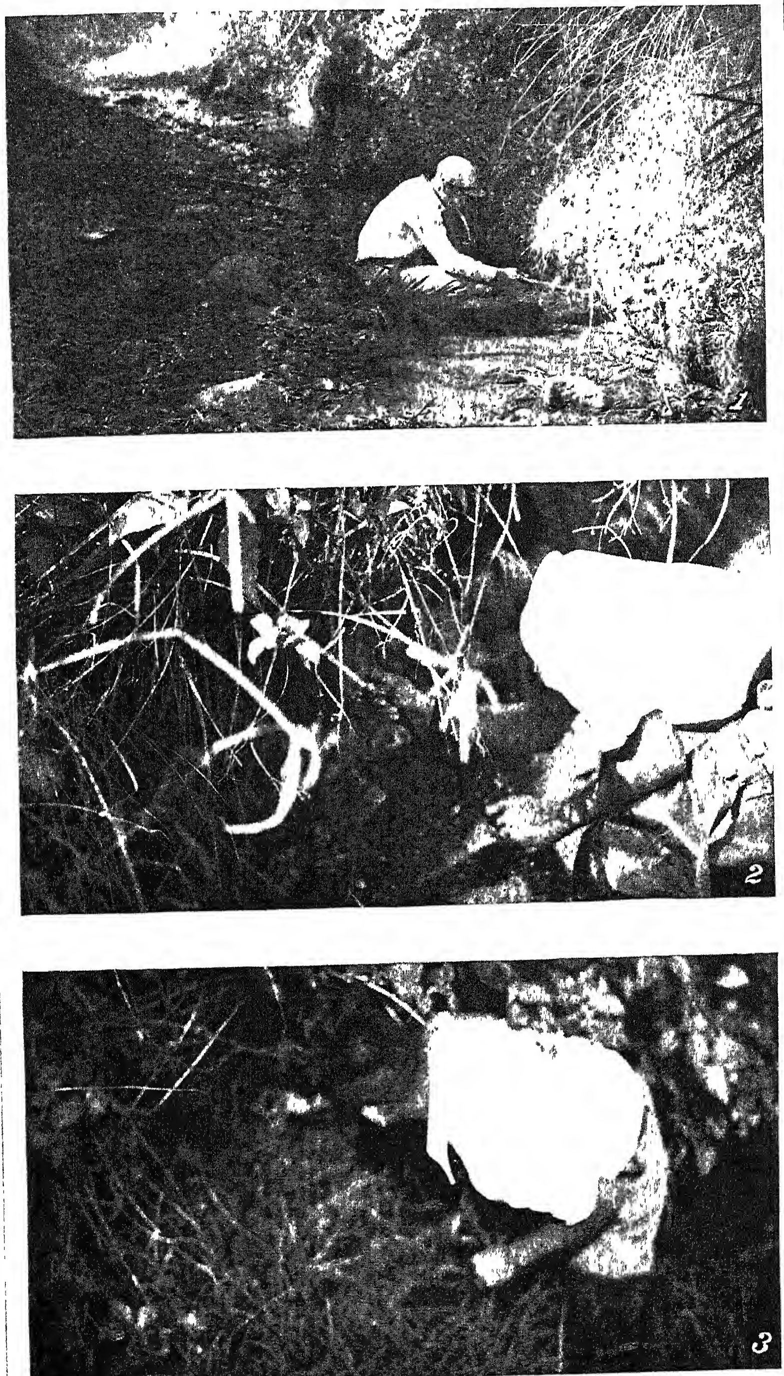


PLATE 3.

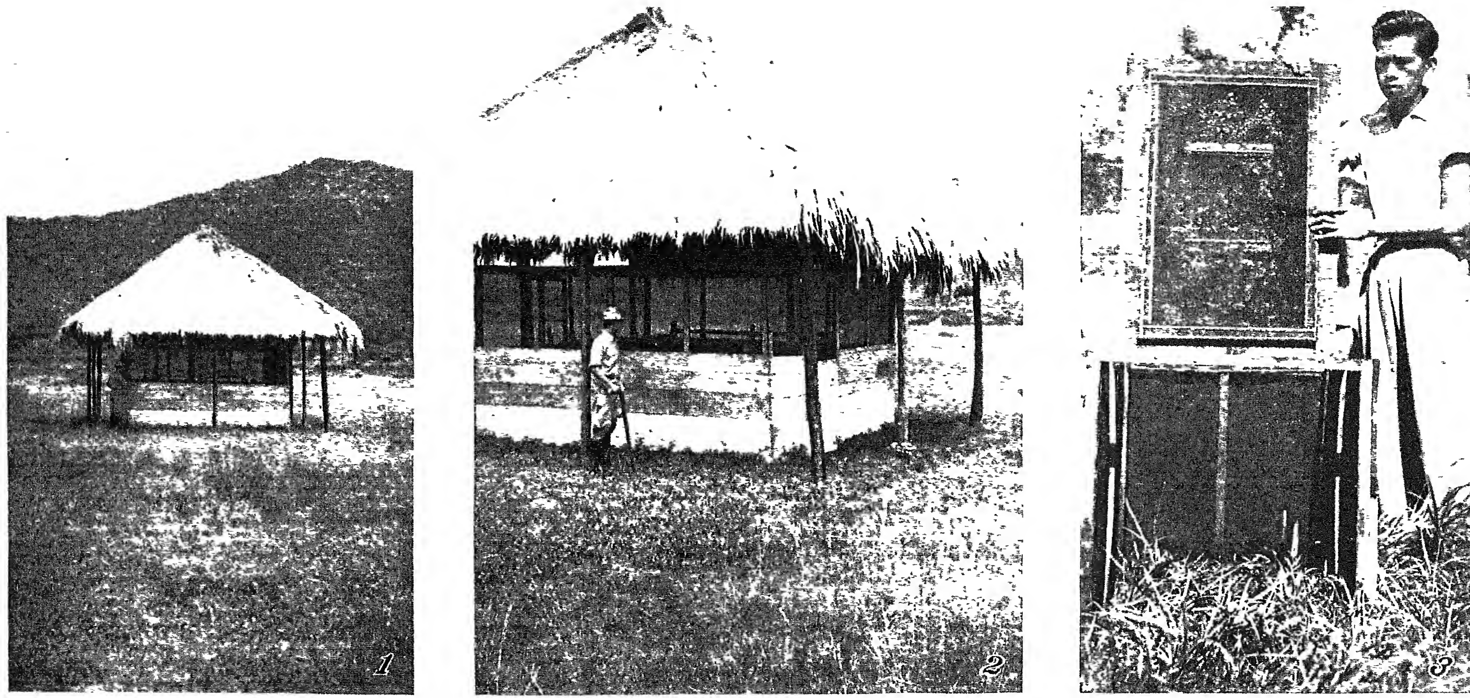
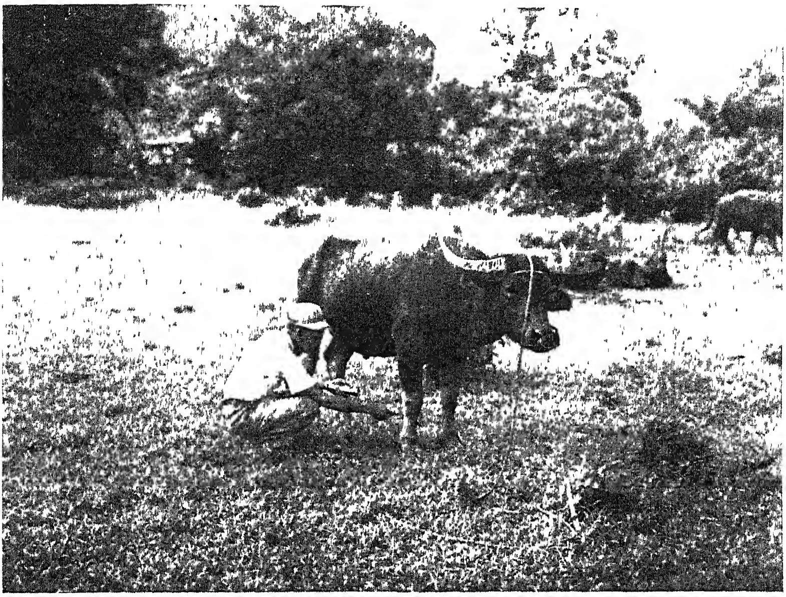


PLATE 4.



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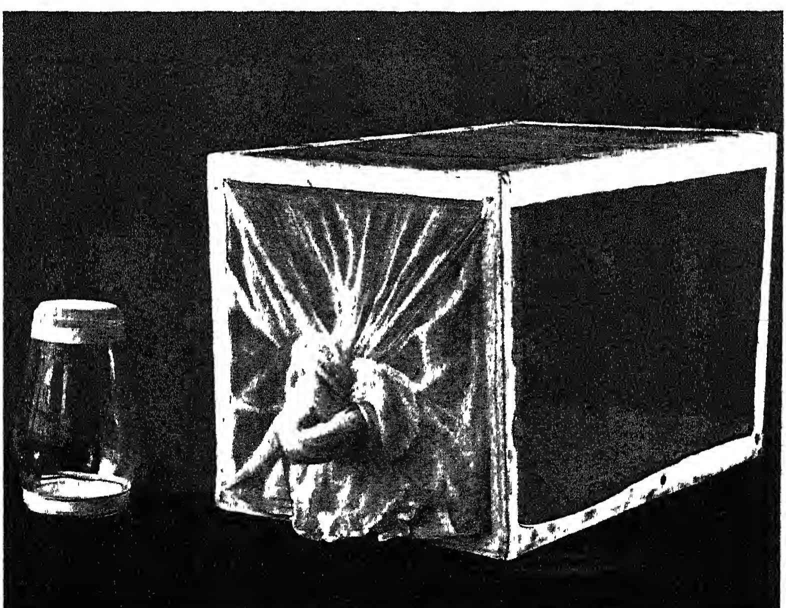

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PLATE 5.

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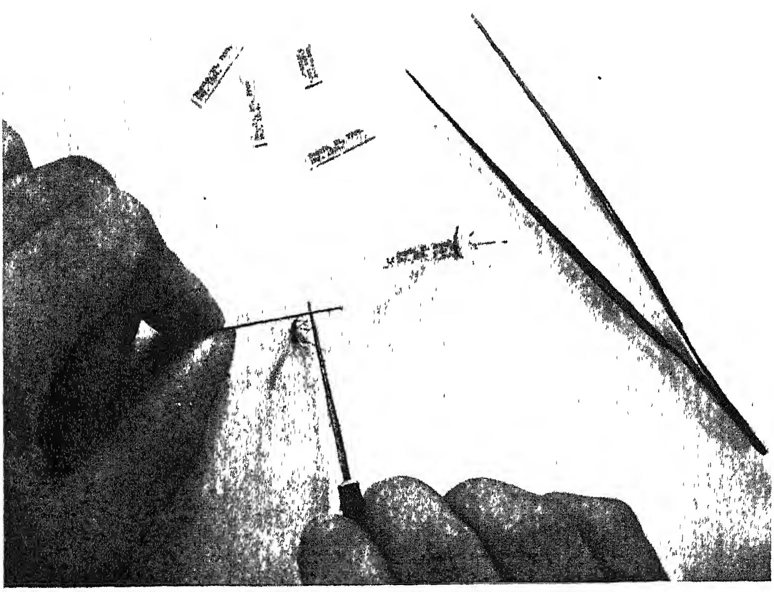

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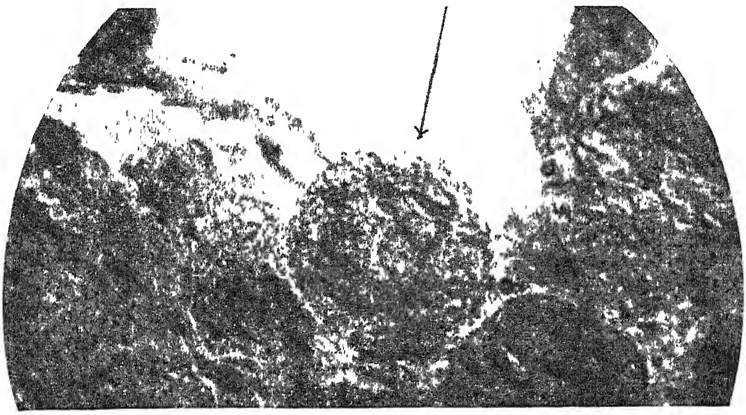
PLATE 6.

PLATE 7.



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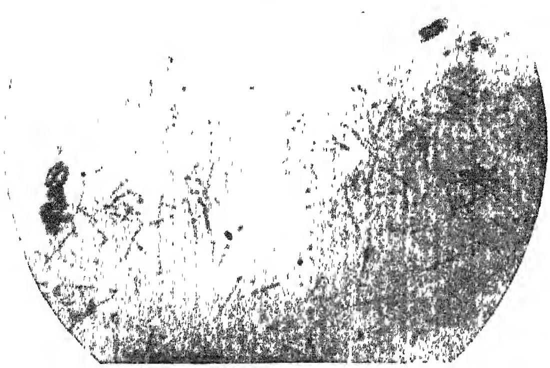

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PLATE 8.

EFFECTS OF CHLORINATED LIME IN LETHAL CONCENTRATIONS ON ENTAMŒBA HISTOLYTICA CYSTS [1]

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ONE PLATE

In an experiment of this nature it is important to establish a safe and satisfactory criterion for determining the viability of the cysts. A review of the literature on the subject reveals that there is no standard criterion by which to determine whether a cyst is dead or living. Various authorities who have worked on the determination of the longevity of *Entamoeba histolytica* cysts in vitro have reported various results with widely varying significant differences, probably because different criteria were used in judging the viability of the cysts.

Kuenen and Swellengrebel (1913), working on the hypothesis that dead cysts stain with a weak solution of eosin in water (1:1,000) and that living cysts do not, found that all the cysts in fæces begin to degenerate in from thirteen to twenty-nine days. The reliability of this result was later discounted by Yorke and Adams (1926), who gave as a proof of their contention the nonexcystation of cysts that they believed to be living in the Locke-egg-serum medium of Boeck and Drbohlav (1925). Penfold, Woodcock, and Drew (1916), determining the viability of the cysts by their power to excyst in the presence of liquor pepticus, stated that although they were able to keep cysts in slow-running water for fifteen days, some certainly were alive at the end of this period. Wenyon and O'Connor (1917), employing the eosin test for viability, claimed that cysts will survive for over thirty days in water. Dobell (1919), cited by Yorke and Adams (1926), employing the eosin test supplemented by morphological observations, found that the maximum viability of cysts in water is five weeks, and that they may be found dead at the end of a week in fæces. Boeck (1921), also

[1] Read before the Third Philippine Science Convention, held in Manila February 28, 1935.

using the eosin test supplemented by morphological observations, stated that *E. histolytica* cysts were viable at the end of one hundred fifty-three days in water. This very high figure led some investigators to doubt the accuracy of such results, and in 1932 Wight and Wight, after observing the viability of the cysts by actual culture, claimed that Boeck never proved that after this long period (153 days) the cysts that he believed survived were capable of perpetuating the species. Long after the cysts are moribund or dead, the wall may retain impermeability for certain dyes. Sellards and Theiler (1924) modified the method of Kuenen and Swellengrebel for determining the viability of the cysts by infecting kittens by intrarectal injections of the cysts instead of per os, and to their disappointment they failed to produce infection even with the use of quite fresh material. Wight and Wight (1932) seemed able to prove that the conclusion of Yorke and Adams (1926), based on cultural methods, were entirely inadequate, and that Dobell's figure (37 days plus), based on the eosin test seemed to be nearer the truth. The same authors claimed that the majority of the dead cysts of Yorke and Adams on Locke-egg-serum medium were still viable when subcultures were made in the same medium. From the latter observation we may infer that cultural methods, no matter how favorable the medium, are not a satisfactory criterion for determining the viability of cysts, because all cysts that have been exposed to the action of one chemical or drug, or any test solution or test medium, will not excyst at the same time, as not all of them have the same resistance. This inference seems to be borne out by the fact that the same authors (Wight and Wight, 1932) found that the preëxcysting forms in Locke-egg-serum medium are similar to dead cysts and vice versa.

From these contradictory, not to say confusing, reports, it seems clear that the results of the different investigators are much at variance. In the writer's opinion these varying results are due to the lack of a standard criterion for judging the viability of the cysts. The writer is carrying on experiments along similar lines but using for determining the viability of cysts an entirely different criterion, based on the principle of cell necrobiosis, which, in the writer's opinion, is more reliable than the criteria used hitherto. Cystologists and physiologists have demonstrated that the nucleus as a whole is the governing body of the cell, and without it the cell is considered dead and beyond resuscitation. No one would deny that the cyst is in the

dormant and resistant state of a living cell which has met unfavorable conditions. That being the case, the nucleus is the most important structure of the cyst. If parts of the protoplasm of a cell are lost, leaving only a very thin rim around the nucleus, as long as the nucleus remains intact the cell is still living, and able to regenerate and to perform its physiological functions. If the nucleus is lost, the whole cell is lost. In other words, a dead cyst may be defined as one whose nucleus or nuclei have been destroyed or have disappeared, and whose cytoplasm is shrunken, coarsely granular, and vacuolated. Cysts that do not answer to this definition are not considered dead.

An opportunity to test the reliability and usefulness of a criterion for the determination of cyst viability presented itself when Dr. A. Ocampo, of the Philippine General Hospital, supplied the writer with fæces from a confirmed case of entamœbic dysentery. There could be no doubt that the patient was suffering from chronic amœbiasis. The cysts present in the fæces answered all the morphological descriptions of typical *E. histolytica* cysts; and, therefore, there seems to be no doubt that *E. histolytica* cysts were used in this study.

In view of the fact that the results of Wenyon and O'Connor (1926), that chlorinated lime tabloids as used for water sterilization had no action on *E. histolytica* cysts, seem unreliable, because their findings were based on the use of eosin as a test for viability; and that the results of Yorke and Adams (1926) are subject to the same criticism, as proven by Wight and Wight (1932), the writer felt justified in making further observations on the action of chlorinated lime on *E. histolytica* cysts. The writer was also influenced by his interest to determine the lowest concentrations lethal to the cysts, because he believes this is important from the standpoint of water sterilization by the use of chlorinated lime, which is now being used in large and small filtration plants and in the sterilization of swimming pools.

In order to forestall errors in this experiment an entirely different line of approach was followed. The chemistry of hypochlorite of lime ($CaOCl_2$), especially its rate of solubility in free chlorine water, was studied, and it was found that 1 gram of the powder will completely dissolve in forty-five minutes in 100 cubic centimeters of water without stirring, and in thirty minutes with stirring. These findings approximate those of Buswell (1923). According to Buswell $CaOCl_2$ is not very soluble

TABLE 1.—*Percentages of different types of Entamoeba histolytica cysts observed in different dilutions of lime at different exposures.*

Hypochlorite of lime dilutions (5 cc).	Cysts observed.	Morphologic descriptions.												Control. Original fæces with 96 per cent = 4 nuclei, 4 per cent = 2 nuclei.
		30 min.	Type.	Per cent.	45 min.	Type.	Per cent.	1 hr.	Type.	Per cent.	1 hr. 15 min.	Type.	Per cent.	
1 : 100	100	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	98	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm very much shrunken and vacuolated.	IV	100	----	----	----	----	----	----	No change.
		Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and vacuolated; chromatoid bodies fragmented.	I	2	----	----	----	----	----	----	----	----	----	

1 1,000	100	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	89	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm shrunken and vacuolated.	IV	95	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm very much shrunken and vacuolated.	IV	100	----	----	----	No change
		Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and vacuolated; chromatoid bodies fragmented.	I	11	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	5	----	----	----	----	----	----	

TABLE 1.—*Percentages of different types of Entamoeba histolytica cysts observed in different dilutions of lime at different exposures*—Continued.

Hypochlorite of lime dilutions (5 cc).	Cysts observed	Morphologic descriptions.												Control. Original fæces with 96 per cent =4 nuclei, 4 per cent =2 nuclei.
		30 min.	Type.	Per cent.	45 min.	Type.	Per cent.	1 hr.	Type.	Per cent.	1 hr. 15 min.	Type.	Per cent.	
1 : 10,000	100	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken; and vacuolated; chromatoid bodies fragmented.	III	86	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm shrunken and vacuolated.	IV	94	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm shrunken and vacuolated.	IV	100				
		Two nuclei distorted and two broken; protoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	10	Two nuclei distorted; protoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	4							

1 : 10,000	100	Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated.	I	4	Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	I	2	....	....	....	....	....	....	No change.
1 : 100,000	100	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken and vacuolated; chromatoid bodies fragmented.	III	80	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm shrunken and vacuolated.	IV	90	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm shrunken and vacuolated.	IV	98	Distorted and broken; four nuclei disappeared; chromatoid bodies disappeared; cytoplasm shrunken and vacuolated.	IV	100	
		Two nuclei distorted and two broken; cytoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	15	Two nuclei distorted and two broken; protoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	6	Two nuclei distorted and two broken; protoplasm shrunken and vacuolated; chromatoid bodies fragmented.	II	2	....	....	....	

TABLE 1.—*Percentages of different types of Entamoeba histolytica cysts observed in different dilutions of lime at different exposures*—Continued.

Hypochlorite of lime dilutions (5 cc).	Cysts observed	Morphologic descriptions.												Control. Original fæces with 96 per cent=4 nuclei, 4 per cent=2 nuclei.
		30 min.	Type.	Per cent.	45 min.	Type.	Per cent.	1 hr.	Type.	Per cent.	1 hr. 15 min.	Type.	Per cent.	
1 : 100,000	100	Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated.	I	5	Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated.	I	4	------	----	----	------	----	----	No change.
		Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	41	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	56							
1 : 1,000,000	100	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	41	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	56	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	72	Four nuclei distorted and broken; karyosome disappeared; cytoplasm coarsely granular, shrunken, and vacuolated; chromatoid bodies fragmented.	III	73	

1 : 1,000,000	100	Two nuclei distorted and two broken; cytoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	39	Two nuclei distorted and two broken; cytoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	24	Two nuclei distorted and two broken; cytoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	20	Two nuclei distorted and two broken; cytoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	20	No change.
		Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated.	I	20	One nucleus broken and three distorted; cytoplasm shrunken and slightly vacuolated; chromatoid bodies fragmented.	II	10	Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated.	I	8	Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated.	I	7	
					Four nuclei distorted; karyosome disappeared; cytoplasm shrunken and slightly vacuolated.	I	10							

and is ordinarily fed as 1 or 2 per cent suspension. This is important to know, because it will enable us to predetermine the strength of the dilutions to be used to test the action of this chemical on the cysts. Judging from the results of Wenyon and O'Connor (1926) and Yorke and Adams (1926) it seems reasonable to suppose that this important fact had been ignored by these authors.

Another important feature in this work was the use of natural fæces instead of washed and concentrated suspensions, as done by Yorke and Adams (1926). While the use of the latter is more ideal than the use of the former, the writer believes, as he points out in his discussion of the results, that the presence of nitrogenous organic matter in the fæces is most necessary in the action of $CaOCl_2$ on the cysts. Some chemical substances are formed in the interaction between calcium hypochlorite and nitrogenous organic matter, and these have a synergistic killing effect on *E. histolytica* cysts. The presence of nitrogenous organic matter in the fæces is always certain, because bacterial decomposition of proteins takes place in the fæces and the bacteria are capable of deamidizing these nitrogenous substances into free ammonia (NH_3) and fatty acids.

METHODS

Sixteen-hour-old fæces of jellylike consistency were stirred thoroughly with a platinum loop 5 millimeters in diameter. One loopful of the fæcal emulsion was spread uniformly on a large slide, covered with a large cover glass, and sealed with paraffin. A total count of the cysts was made under a high-power lens after the manner of Stoll's egg-counting technic; that is, by the use of a square fenestra attached to the eye piece and a cliquer. Counts were made on several such preparations, and it was found that each loopful contained an average of fifty-six cysts. The types of cysts present were 96 per cent quadrinucleates and 4 per cent binucleates (Plate 1, figs. 1 and 2).

After the average number of cysts per loopful was determined, 1 per cent solution of calcium hypochlorite ($CaOCl_2$) in distilled water was prepared by shaking the preparation vigorously in a tightly stoppered flask until the $CaOCl_2$ was completely dissolved. From this original solution varying dilutions up to 1 : 1,000,000 were made. Five cubic centimeters of each of these test solutions were placed in a tightly stoppered test tube and the series arranged in sequence in a test-tube rack. Four loop-

fuls of the fæces were inoculated to each test tube containing the test solution. By means of a capillary pipette two drops were taken from the bottom of each test solution after thirty minutes and spurted on a slide, covered with a cover glass, and examined under an oil-immersion objective. A careful study was made of the internal organization of each cyst that came under observation, and the ratio between living cysts and the dead ones determined by use of the aforementioned criterion. This procedure was repeated in another series, in which washed and concentrated suspensions of *E. histolytica* cysts were used instead of fæces containing cysts. The results are shown in Tables 1 and 2.

TABLE 2.—*Percentages of different types of washed Entamœba hystolytica cysts that were observed in different dilutions of hypochlorite of lime.*

Hypochlorite of lime dilutions (5 cc).	Types of *Entamoeba histolytica* cysts.								Control. Concentrated and washed *E. histolytica* cysts with 96 per cent = 4 nuclei, 4 per cent = 2 nuclei.
	30 min.	Per cent.	45 min.	Per cent.	1 hr.	Per cent.	1 hr. 15 min.	Per cent.	
1 : 100	III	62	IV	44	IV	84	IV	100	
	II	20	III	42	III	16			
	I	18	I	14					
1 : 1,000	III	53	III	60	III	72	IV	51	
	II	26	II	22	II	28	III	49	
	I	21	I	18					
1 : 10,000	III	44	III	53	III	64	IV	42	
	II	28	II	33	II	23	III	58	No change.
	I	28	I	14	I	13			
1 : 100,000	II	64	III	26	III	32	III	33	
	I	36	II	40	II	47	II	46	
			I	34	I	21		21	
1 : 1,000,000	II	43	II	48	III	27	III	29	
	I	57	I	52	II	51	II	50	
					I	22	I	21	

DISCUSSION

Table 1 shows that while striking changes could be noted in the structure of the cysts exposed to different tests solutions, no changes at all occurred in those in the control tubes. The highest dilution of calcium hypochlorite ($CaOCl_2$) that will kill *E. histolytica* cysts after one hour fifteen minutes exposure is 1:100,000. This concentration, when reduced to parts per million, is equal to 10 parts per million; or, when expressed in chlorine, it is equal to 3.5 parts per million, because the available

chlorine present in the solution is 35 per cent. Aside from these striking changes, several types of degenerative changes in the cysts were found, not only in single test solutions but in all of them at different exposures. The results indicate beyond a doubt that calcium hypochlorite ($CaOCl_2$) really exerts a deleterious influence on *E. histolytica* cysts.

The efficiency of $CaOCl_2$ in killing *E. histolytica* cysts noted in this work is attributed by the writer to the fact that cysts were inoculated immediately after this chemical has been completely dissolved, allowing a maximum ionic action of the solution on the exposed cysts. It is presumed that either the hypochlorous (HClO) or chlorine (Cl) ions may penetrate the cyst wall and there act on the protoplasm of the cyst by oxidation. The chlorine (Cl_2) excess liberated by $CaOCl_2$ that does not act on cysts may by its addition and substitution reactions act on the decomposition products of protein, which are mostly nitrogenous organic compounds present in the fæces. Dakin et al. (1916) found that the combination of Cl_2 with nitrogenous organic matter forms strong antiseptic chloramines, which have stronger bactericidal action than chlorine, due to their greater solubility and penetrating power. They do not decompose spontaneously as does HClO and, therefore, their entire strength is maintained for a longer time. In this work greater action of $CaOCl_2$ was expected because the preparation that contained the cysts also contained organic matter.

By repeating the experiment of Yorke and Adams (1926) simultaneously with the first experiment, the writer found that only a 1 : 100 dilution of $CaOCl_2$ can kill *E. histolytica* cysts after one hour fifteen minutes exposure (Table 2). This result partly confirmed their conclusion in 1926 that only high concentrations of $CaOCl_2$ can kill *E. histolytica* cysts. It seems, however, that in the 1 : 100 dilution of $CaOCl_2$ the action of the chemical is not wholly due to Cl_2, but partly to traces of chloramines formed from the small quantity of nitrogenous organic matter which was left with the cysts after several washings and centrifugations. It is natural to expect, therefore, that in a concentrated fæcal emulsion this killing power may be tremendously multiplied, since it destroys cysts in a dilution as weak as 1 : 100,000.

APPLICATION OF CHLORINATED IODIZED SOLUTION

In order to find the lowest concentration of $CaOCl_2$ suitable for internal administration, the writer repeated the same procedure and made a series of dilutions of $CaOCl_2$ from 1: 1,000,000 to 5: 1,000,000, and to every 5 cubic centimeters of the test solution a 5 per cent solution of potassium iodide (KI) saturated with iodine was added to form a 0.5 per cent solution in the various concentrations of $CaOCl_2$. The fæcal material used in the previous experiment was utilized. To his surprise he found the same structural changes with slight deviations from those in Table 1 at different exposures. He found that the lowest concentration of $CaOCl_2$ solution with iodine that will kill *E. histolytica* cysts after one hour fifteen minutes is 4 : 1,000,000. The available chlorine (Cl_2) is about 35 per cent; so that, expressing this in parts per million of Cl_2, it is 1.4 parts per million with 0.5 per cent part of iodine (Table 3).

TABLE 3.—*Percentages of different types of Entamœba histolytica cysts observed in different dilutions of chlorinated iodized solutions.*

Hypochlorite solution with iodine in 0.5 per cent parts.	Types of *Entamoeba histolytica* cysts.								Control. Original fæces with 96 per cent = 4 nuclei, 4 per cent = 2 nuclei.
	30 min.	Per cent.	45 min.	Per cent.	1 hr.	Per cent.	1 hr. 15 min.	Per cent.	
1 : 1,000,000	III	42	III	58	III	73	III	75	
	II	38	II	32	II	20	II	19	
	I	20	I	10	I	8	I	6	
2 : 1,000,000	III	47	III	72	III	77	III	82	
	II	35	II	29	II	17	II	18	
	I	18	I	9	I	6	------	------	
3 : 1,000,000	III	58	III	76	III	84	III	91	No change.
	II	30	II	25	II	13	II	9	
	I	17	I	7	I	3	------	------	
4 : 1,000,000	III	81	III	92	IV	96	IV	100	
	II	14	II	6	III	4	------	------	
	I	5	I	2	------	------	------	------	
5 : 1,000,000	III	90	IV	97	IV	100	------	------	
	II	7	III	3	------	------	------	------	
	I	3	------	------	------	------	------	------	

The mechanism of action of these two chemicals seems to depend on the production of two nascent halogens of chlorine (Cl_2) and iodine (I_2), which are believed to have strong pene-

trating power through the cyst walls. The nascent Cl_2 of $CaOCl_2$ liberates I_2 from KI, and this nascent iodine (I_2) plus free I_2 and Cl_2 are perhaps enough to kill the cysts. We must not forget that the chloramines formed seem to act also on the cysts, and these help the two halogens in their killing power. The writer can think of no other explanation to account for this killing power.

The above results naturally suggest the possibility of using this solution in the treatment of the "cyst-carrier state," which Craig (1932) defined as a stage of amœbiasis where symptoms may be present or absent and, if present, mild and atypical, the condition being characterized by normal or frequent bowel movements with abundant cysts in the stool. It is true that a large percentage of the cysts in the colon are found in the lumen mixed with fæces, and a small percentage in the crypts of the mucosal folds. In the selection of the chemical to kill these cysts, the one that will act directly on the cysts and is, if possible, nonirritating, easily absorbed, excreted by the system, and effective in small doses should be chosen. Considering the concentration of calcium hypochlorite ($CaOCl_2$) and iodine in this mixture, 1.4 parts per million of available chlorine (Cl_2) is suitable for human use and 1 per cent of iodine is the average dose of the United States Pharmacopœia. In this solution the writer has only 0.5 per cent iodine, which is 50 per cent less than that permitted by the pharmacopœia and his experience as well as that of others shows that 0.5 per cent iodine in water enemata produces no toxic effects, except a mild irritation. It was shown also by Sollmann (1917) that iodine is easily absorbed in the colon and easily excreted by the system, especially by the salivary glands and kidneys. Furthermore, many drugs in the market contain iodine. Some of them, as summarized by Muhlenns (1921), are iodoxyquinoline sulphate, iodochloroxyquinoline, sodium iodoxyquinoline sulphonate (chinioform), iodochloroxyquineline (vioform), and the popular Yatren 105. While all these drugs contain iodine as the basic principle, and while various authors claim them to be efficacious, the writer believes that chlorinated iodized solution can be used with advantage, because of its low cost and easy preparation. Although the efficacy of this solution has not been tried in vivo, it certainly holds promise in the treatment of cyst carriers.

SUMMARY AND CONCLUSIONS

It may be inferred from the results of the foregoing experiments—

1. That the structural changes based on necrobiosis of the cell constitute an accurate and reliable criterion of the viability of *Entamœba histolytica* cysts.

2. That calcium hypochlorite ($CaOCl_2$) solution is destructive to *E. histolytica* cysts even in as low a concentration as 1: 100,000 or 3.5 parts per million of chlorine.

3. That the presence of nitrogenous organic matter enhances greatly the destructive power of calcium hypochlorite ($CaOCl_2$) to *E. histolytica* cysts.

4. That the concentration of 3.5 parts per million of chlorine (Cl_2), which is effective in killing *E. histolytica* cysts, is not suited for human use and cannot be recommended to free drinking water from entamœba cysts.

5. That solutions of 4: 1,000,000 calcium hypochlorite ($CaOCl_2$) and 0.5 per cent iodine are also lethal to *E. histolytica* cysts, and may be tried in the treatment of cyst carriers.

ACKNOWLEDGMENTS

The writer is indebted to Dr. Candido M. Africa, head of the Department of Parasitology, School of Hygiene and Public Health, University of the Philippines, for his suggestions and criticisms during the progress of this work, and for his patience in reading the manuscript.

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ILLUSTRATION

[All figures are camera-lucida drawings of *Entamœba histolytica* cysts in the fresh state and after treatment with various dilutions of chlorinated lime solutions. × 1,800.]

Plate 1

Figs. 1 and 2. Tetranucleate and binucleate cysts in the fresh state in fæces.

3 to 6. Various stages of degenerated cysts under type I.

7 to 10. Various stages of degenerated cysts under type II.

11 to 14. Various stages of degenerated cysts under type III.

15 to 18. Various degenerated and dead cysts under type IV.

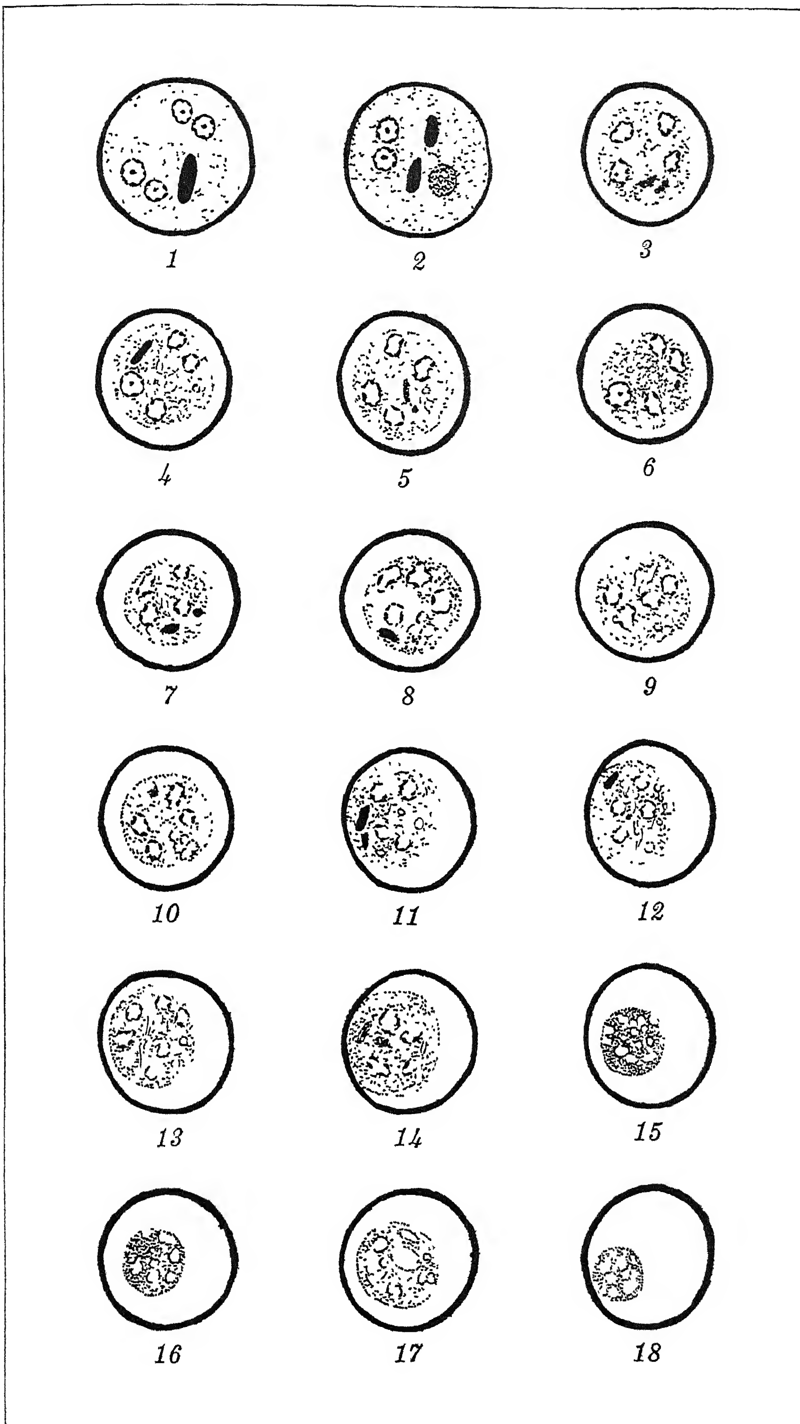

PLATE 1.

STYRAX IN THE PHILIPPINES

By Elmer D. Merrill
Director-in-Chief, New York Botanical Garden
and
Eduardo Quisumbing
Curator, Philippine National Herbarium, Bureau of Science, Manila

ONE PLATE

While the junior author was studying some of the specimens collected in 1930 in the Batan and the Babuyan Islands by Messrs. Gregorio Edaño and Maximo Ramos (deceased), botanical collectors of the Bureau of Science, his attention was called by Mrs. Mary S. Clemens to the possibility of one of the specimens (flowering) being *Styrax*. More critical study of other specimens on hand proved this to be true.

Several botanical expeditions have been made to the Batanes and the Babuyanes, which form the northern portion of the Philippine Archipelago, and a report on a collection of plants from these islands was made by E. D. Merrill.[1] The Batanes and the Babuyanes are separated from Formosa by Bashi Channel. All of these expeditions brought some plants which were new to the Philippines, but known from Formosa. More intensive explorations of these islands will yield further data on the floristic relationships of this group of islands with Formosa.

The family is new to the Philippines except for F. Villar's erroneous record of *Styrax benzoin* Dry. as a Philippine plant, Novis. App. (1880) 127.

STYRACACEÆ

Genus STYRAX Linnæus

STYRAX PHILIPPINENSIS Merr. and Quis. sp. nov.

Frutex 2 ad 3 m altus, ramosus, ramis teretibus, glabris, ramulis gracilibus, pubescentibus. Foliis brevissime petiolatis, ovatis vel ovato-lanceolatis, acuminatis, 4.5 ad 9.5 cm longis, 2 ad 6 cm latis, supra glabris, subtus parce stellato-pubescen-

[1] Philip. Journ. Sci. § C 3 (1908) 385–442, map.

tibus, margine obscure serrulato vel subintegro, nervis utrinque 4 vel 5. Racemis 2- ad 3-floris, breviter pedunculatis, 10 ad 13 mm longis, dense pubescentibus. Calycibus campanulatis, 4 vel 5 mm longis, extus stellato-pubescentibus, intus glabris, 5-lobatis, lobis late triangularibus, 0.5 ad 1 mm longis, apice truncatis vel rotundatis, minute apiculatis. Corolla campanulata; petalis utrinque dense adpresse stellato-hirsutis, oblongo-ellipticis, obtusis, 16 ad 17 mm longis, 7.5 ad 8.5 mm latis. Staminibus 10, aequalibus, 2-seriatis, 9 ad 10 mm longis, filamentis 5 ad 6 mm longis, sursum glabris, deorsum tomentosis. Ovario globoso, tomentoso, stylo 15 ad 20 mm longo, apice truncato. Fructibus ellipsoideis, 12 ad 13.5 mm longis, 8 ad 10 mm diametro, ad basim irregulariter fissis, 1-locellatis, apice rostratis. Seminibus oblongis, 10 ad 11 mm longis, 5 ad 6 mm diametro, 3-sulcatis.

A branching shrub, 2 to 3 m high; stems terete, glabrous, reddish brown or nigrescent, the branchlets slender, pubescent. Leaves very shortly petioled, subchartaceous, ovate to ovate-lanceolate, acuminate, 4.5 to 9.5 cm long, 2 to 6 cm wide, upper surface glabrous, reddish brown or nigrescent, the lower surface paler, stellate-pubescent, margins obscurely serrulate or subentire, the lateral nerves very slender, 4 or 5 on each side of the midrib; petioles 4 to 6 mm long. Racemes 2- or 3-flowered at the ends of the branchlets. Flowers white, pedicels 10 to 13 mm long, densely pubescent. Calyx campanulate, 4 to 5 mm long, sparingly stellate-pubescent without, glabrous within, 5-lobed, the lobes broadly triangular, 0.5 to 1 mm long, apex truncate or rounded, with a minute apiculum. Corolla campanulate; the petals densely adpressed stellate-hirsute on both surfaces, oblong-elliptic, obtuse, 16 to 17 mm long, 7.5 to 8.5 mm wide. Stamens 10, equal, 2-seriate, 9 to 10 mm long; filaments somewhat flattened, 5 to 6 mm long, the upper portion glabrous, the basal part tomentose; anthers linear. Ovary globose, tomentose, 1-celled; style 15 to 18 mm long; stigma truncate. Capsule ellipsoid, apex rostrate, 12 to 13.5 mm long, 8 to 10 mm in diameter. The pericarp ligneous, coriaceous, straw-colored, when dry having a tendency to split irregularly into three valves. Seeds oblong, flat on one side, brownish, 10 to 11 mm long, 5 to 6 mm in diameter, 3-sulcate.

PHILIPPINES, Camiguin Island, Mount Malabsing, *Bur. Sci. 79248 Edaño* (type), March 9, 1930 (flowering specimen).

Batan Island, Mount Matarem, *Bur. Sci. 80424 Ramos,* June 20, 1930 (fruiting specimen).

A species manifestly allied to *Styrax japonicus* Sieb. and Zucc. and to *S. kotoensis* Hayata, of Formosa, and should, we believe, be considered to be a northern type in the Philippine flora. It differs from *S. kotoensis* Hayata, the flowers of which have not been described, in its smaller leaves.

ILLUSTRATION

PLATE 1

Styrax philippinensis Merr. and Quis. sp. nov.: *1*, Habit of flowering branch, × 0.5; *2*, mature flower, × 1.5; *3*, mature flower with two petals and part of calyx removed showing attachment of five stamens and pistil, × 1.5; *4*, petal, flattened, × 2.5; *5*, stamen, × 2.5; *6*, fruit, × 1.5; *7*, seed, × 1.5.

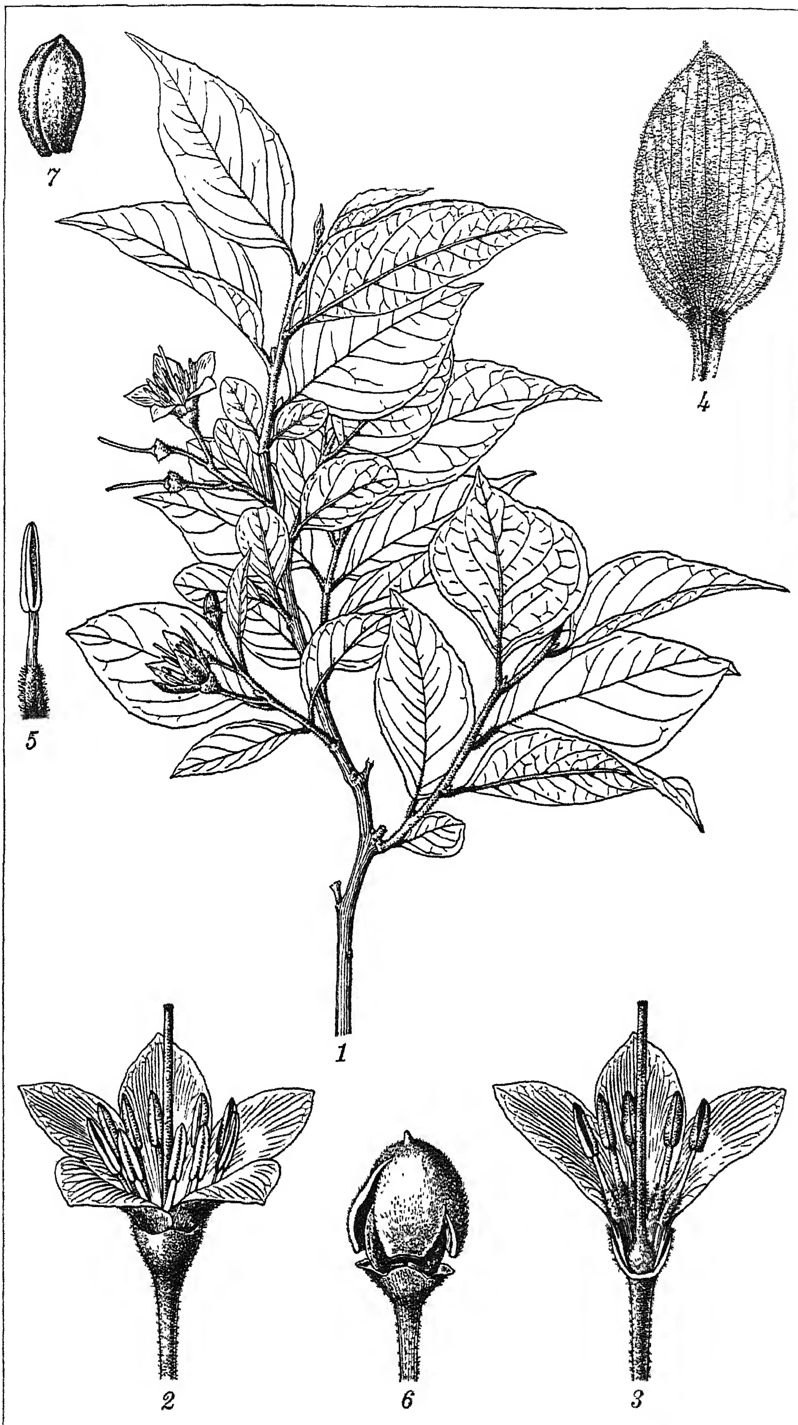

PLATE 1.

LITTLE-KNOWN FISHES FROM THE PHILIPPINES

By Agustin F. Umali

Of the Fish and Game Administration, Bureau of Science, Manila

ONE PLATE

This paper is a systematic description of three rare Philippine fishes based on seven specimens collected from the Manila markets and Lingayen Gulf, Pangasinan Province, mixed with the catches of the beam trawls. They form a part of the ichthyological collection of the Fish and Game Administration, Bureau of Science.

URANOSCOPIDÆ

STARGAZERS

Body elongate, cuboid anteriorly and somewhat compressed posteriorly, widest and usually deepest at occiput. Either naked or covered with very small, cycloid adherent scales arranged in very oblique series running downward and backward; those on belly inconspicuous or obsolete. Head large, flattened above, below, and on sides, almost completely cuirassed with bony plates. Eyes small, on upper anterior portion of head. Mouth vertical with strong and prominent mandible; villiform teeth on jaws, vomer, and palatines; with or without pointed and conical canines; no molars. Maxillary broad, without supplemental bones, not slipping under preorbital. Lateral line continuous, running high. One or two dorsal fins, spinous portion usually much less developed and shorter than soft; anal developed similar to soft dorsal; caudal not forked; pectorals large with broad oblique bases, lower rays rapidly shortened; ventrals jugular, close together, with one spine and five rays. Gill openings wide, continued forward; gill membranes nearly separate, free from isthmus. Branchiostegals 6; air bladder absent.

Carnivorous fishes, living at shore bottoms of tropical seas, northwards to the Mediterranean and Japan, southwards to South Australia and New Zealand.

Genus URANOSCOPUS Linnæus

Uranoscopus LINNÆUS, Syst. Nat. ed. 10 (1758) 250.

Body more or less cylindrical, covered with small and rudimentary scales. Head large, broad, almost wholly covered with bony plates, occipital plates extending to orbits. Opercles and shoulder bones usually armed. Generally a rounded orifice above opercle besides posterior gill opening. Eyes on upper surface of head. Cleft of mouth vertical, generally with a filament below and before tongue. Villiform or cardiform teeth on jaws, vomer, and palatines; no canines. Two separate dorsals, the first with from three to five spines; ventrals jugular. Lateral line continuous, running high. Air vessel absent. Pyloric appendages in moderate numbers.

URANOSCOPUS JAPONICUS Houttuyn. Plate 1, fig. 1.

Uranoscopus japonicus HOUTTUYN, Holl. Maats. Wet. Harlem (1782) 311; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 23 (1901) 745.

Uranoscopus asper TEMMINCK and SCHLEGEL, Fauna Japonica, Poiss. (1842) 26, pl. 9, fig. 1; GÜNTHER, Cat. Fishes 2 (1860) 226; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 23 (1901) 369.

Dorsal III–IV, 14–15; anal 13–14; pectoral 17–18; scales in transverse series about 60.

Body rather elongate, broad anteriorly and compressed toward caudal peduncle; depth 3.6 in length. Head flat above and on sides, with moderately rugose bony plates, dorsal plate extending forward between eyes where it is divided by a deep U-shaped, naked depression; preorbital plate with a flat spine; preopercle with four short spines on lower edge and another stronger one at anterior border of subopercle; humeral spine sharp and long, about 3.2 in length of head,[1] a short flat spine above this. Head 3 in body length; greatest width 1.4 in length of head. Snout very short, 7 in head; mouth vertical; maxillary 2.1 in head; teeth conical and movable in two or three rows in upper and lower jaws, in villiform bands on vomer, palatines, and pharyngeals. Eye small, on upper side of head, 5.8 in head, its horizontal diameter equal to interorbital. Gill rakers on first arch obsolete, represented by a few small bunches of setæ.

Scales small, square, deeply embedded; arranged in about sixty oblique rows; occiput, breast, and belly, as well as a narrow strip along base of dorsal, and a narrow area along base of anal fin

[1] The length of head includes the lower jaw in the description of the species of this family.

naked; lateral line running high, extending along base of dorsal fin abruptly descending to middle of base of caudal at region of caudal peduncle. Dorsals separate, the first with three or four short flexible spines, the highest about 3.5 in head, and the last hardly visible in most specimens as in Plate 1, fig. 1; anterior rays highest, 1.9 in head. Anal inserted below first ray of second dorsal, its fin membrane and especially branched portion of rays fleshy; caudal convex posteriorly, middle rays of pectoral longest; ventrals about 2 in head, three pairs of strong spines directed forward projecting from their bases.

Color of fresh dead specimen, uniform dark brown above, fading to grayish white towards sides, white on belly; spinous dorsal black, basal fin membrane white; soft dorsal and caudal yellowish gray, the former with dusky spots along rays; anal dusky posteriorly, other portions yellowish with white edge; pectorals yellowish with narrow white margin; ventrals white, the edge dusky.

Color in alcohol brownish, fading to whitish toward belly. Spinous dorsal black, with narrow white band at base, the spots along fin rays totally faded; all other fins yellowish, anal and ventrals paler.

Description based on five specimens, No. 31250, total length 150 millimeters, obtained from Quinta Market, Manila, October 25, 1930; Nos. 41063, 41064, 41065, and 51565, 117, 108, 128, and 154 millimeters in total length, respectively; all collected from Lingayen Gulf, Pangasinan, October 3, 1934.

URANOSCOPUS BICINCTUS Temminck and Schlegel. Plate 1, fig. 2.

Uranoscopus bicinctus TEMMINCK and SCHLEGEL, Fauna Japonica, Poiss. (1842) 26, pl. 10, B; BLEEKER, Act. Soc. Nederl., II, Amboina (1857) 411; GÜNTHER, Cat. Fishes 2 (1860) 228; NYSTROM, Svensk. Vet. Akad. (1887) 28; ISHIKAWA, Prel. Cat. (1897) 46.

Dorsal IV, 13; anal 13; pectoral 18; scales in transverse series about 75.

Body robust anteriorly and compressed posteriorly, broader than deep on head; depth 4 in length. Head flat above, covered with coarsely granular bony plates throughout except a narrow U-shaped naked portion at interorbital; preorbital with a flat blunt spine; preopercle with four short spines directed downward on lower edge, another stronger spine at anterior border of suboperculum; humeral spine short and stout, about 5 in head, two short spines above and anterior to this, at superior angle of operculum. Head about 2.7 in body length; greatest width

about 1.2 in length of head. Snout very short, 6.4 in head; mouth vertical; maxillary 2.6 in head; teeth conical and movable, in narrow bands in upper and lower jaws, in villiform bands on vomer, palatines, and pharyngeals. Eye prominent on upper side of head, 7.7 in head, its horizontal diameter contained 1.4 in interorbital. Gill rakers on first arch obsolete, represented by a few small bunches of setæ.

Scales small, square, deeply embedded; arranged in about seventy-five oblique rows; naked at occiput, breast, and belly, as well as a narrow strip along base of dorsal and anal. Lateral line extends along base of dorsal fin, curving downward to middle of caudal fin at region of caudal peduncle. Dorsals separate, first dorsal of four short, flexible spines, the longest 4.5 in head; second dorsal of thirteen rays, third ray longest, 2.2 in head. Anal inserted below origin of second dorsal; fin membrane, especially at branched portion of rays, fleshy; caudal somewhat convex; middle rays of pectoral longest; ventrals 2.1 in head, three strong spines directed forward projecting from base of fin.

Color in alcohol, blackish brown above, fading to grayish white towards lower sides and belly; head and sides of body speckled with minute dark dots; a broad, dark blotch (somewhat indistinct in my specimen) passes around body through base of first dorsal, and an obscure black spot below posterior base of second dorsal. First dorsal black, with a white spot at anterior and posterior of base. Second dorsal dusky, especially towards margins, dotted with black. All other fins dusky yellowish with small black spots; anal, pectorals, and ventrals with white edges.

Here described from a single specimen, No. 31249, total length 262 millimeters, obtained from Divisoria Market, Manila, January 10, 1931.

Found on the coasts of Japan and southward.

OPHIDIIDÆ

CUSK EELS

Body elongate, compressed, more or less eel-shaped; either naked or covered with very small cycloid scales embedded in skin and arranged in oblique series at right angles to each other. Head large, naked or partly scaled; lower jaw included. Mouth moderately protractile, both jaws and generally vomer and palatines also, with villiform or cardiform teeth. Barbels present or absent. Eyes moderate in size, rudimentary or entirely

wanting. Lateral line more or less distinct. Vertical fins of soft rays only; confluent with each other. Pectoral fins sometimes wanting. Ventral fins each reduced to a pair of filaments or a bifid ray inserted just behind chin between rami of lower jaw. Gill openings very wide; gill membranes separate, attached to isthmus behind ventrals. Pseudobranchiæ small; gills 4, a slit behind fourth. Air bladder and pyloric cæca present.

Small, marine carnivorous fishes found in most warm seas, some descending to considerable depths in the Atlantic, Pacific, and Indian Oceans.

Genus LEPOPHIDIUM Gill

Leptophidium GILL, Proc. Acad. Nat. Sci. Phila. (1863) 210.
Lepophidium GILL, Am. Nat. 29 (1895) 167.

Body elongate, more or less compressed, decreasing gradually in height towards posterior where it ends abruptly in a point; scales regularly imbricate in quincunx. Head with imbricated scales extending to forehead; snout high, obtusely rounded, and projecting forward, with or without a short, nearly concealed spine directed forward and somewhat downward; mouth moderate, oblique; teeth in jaws villiform, embedded in a mucous membrane, separated by an interval from longer and pointed ones in outer row; vomer and palatines with teeth.

LEPOPHIDIUM MARMORATUM Goode and Bean. Plate 1, fig. 3.

Leptophidium marmoratum GOODE and BEAN, Proc. U. S. Nat. Mus. 7 (1885) 423; GOODE and BEAN, Oceanic Ichthyology (1895) 348, fig. 308.

Dorsal about 90; anal about 60; series of scales along lateral line about 86.

Body more or less elongate and eel-like, moderately compressed anteriorly and ribbonlike posteriorly, and gradually tapering to a point at tail; depth 5.6 in length. Head scaled on cheeks and forehead, 4.5 in body length; snout blunt, without spines, projecting forward over mandible, 4.1 in head, equal to interorbital. Mouth moderate, oblique with villiform teeth on jaws, vomer, and palatines, outer series larger and movable; maxillary extending slightly beyond vertical through posterior margin of orbit, its length equal to postorbital portion of head. Eyes lateral and moderate, 3.2 in head, somewhat exceeding snout. Opercle ending in a small spine somewhat hidden in opercular flap.

Scales small, cycloid, closely imbricate, about eighty-six along lateral line; lateral line apparently complete. Dorsal low, of

about ninety soft rays, confluent with caudal and anal; anal of about sixty soft rays. Pectoral fins short, the length 2 in head. Branchiostegals seven; pseudobranchiæ present; gill-rakers short, eight below angle of first arch, the longest about 0.3 diameter of eye.

Color in alcohol yellowish, lighter towards belly and under-surface of head. A broad brown blotch on forehead continued downward as an oblique band along posterior border of eye to lower edge of opercle; two brown bands on nape before dorsal origin running obliquely downward to belly, the posterior one sending a branch as a longitudinal stripe along whole length of lateral line; another brown stripe along base of dorsal fin. Anterior half of dorsal fin white with irregular blackish to black blotches; posterior half of dorsal, caudal and anal blackish brown, base and outer edges white. Pectorals and ventrals whitish, base of former brownish or dusky.

Description based on a single specimen, No. 31248, total length 140 millimeters, obtained from Divisoria Market, Manila, November 26, 1930.

ILLUSTRATION

[Drawings by Angel D. Lagman.]

PLATE 1

FIG. 1. *Uranoscopus japonicus* Houttuyn.
2. *Uranoscopus bicinctus* Temminck and Schlegel.
3. *Lepophidium marmoratum* Goode and Bean.

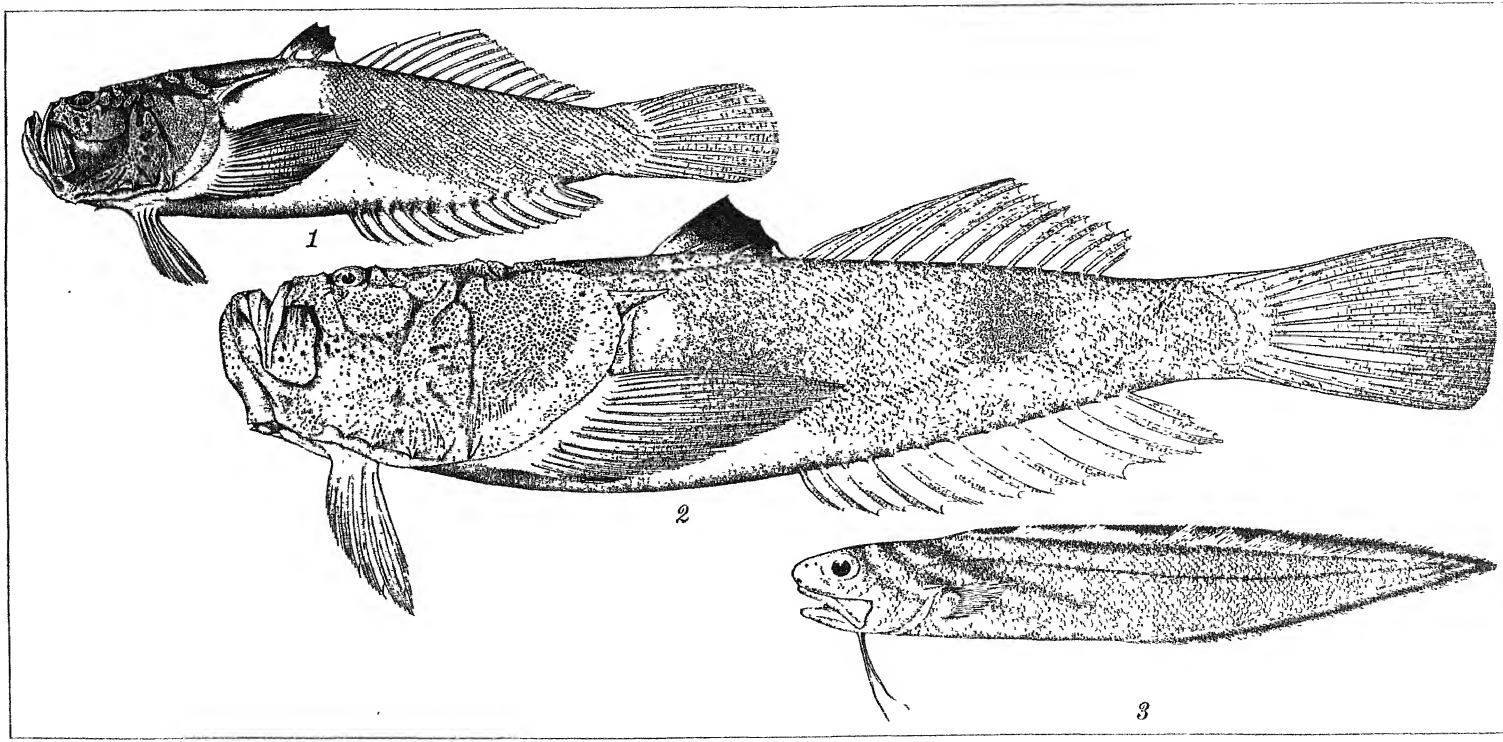

PLATE 1.

A COLLECTION OF SPONGES FROM PUERTO GALERA MINDORO, PHILIPPINE ISLANDS

By M. W. DE LAUBENFELS
Of Altadena, California

ONE PLATE

Prof. Hilario A. Roxas, formerly of the University of the Philippines, has transmitted to me for identification a small but interesting collection of sponges. These were all collected near the marine biological station of the University of the Philippines, which is situated at Puerto Galera Bay, Mindoro Island, Philippine Islands. The sponges are exclusively from very shallow water, in no case more than 12 meters deep. Two of the nine species that could be identified proved to be new, which is very remarkable. It is earnestly hoped that more work will be done with the Porifera at this marine station. Several of the forms in question should prove very interesting for physiological experimentation.

None of them belongs to the class Calcispongiæ, and since this collection is exclusively from shallow waters, none is of the class Hyalospongiæ. The nine species represent nine genera of the class Demospongiæ.

Probably the most extensive treatise on the sponges of the Philippine regions is that by H. V. Wilson.[1]

DYSIDEA PALLESCENS (Schmidt).

The Puerto Galera sponge here described is a massive to irregularly lamellate specimen, gray, tinged with lavender, as preserved in alcohol. Its consistency is spongy. There is a smooth, presumably horny, dermis, as is true of keratose sponges in general, and it is stretched over conules 2 mm high and 1 to 8 mm apart. Underneath this dermal membrane there probably have been subdermal cavities, but in general these are collapsed at the time of examination. The pores and oscules are not evident. In the endosome there is an obvious reticulation of the fibers. The flagellate chambers are eurypyllous, 40 μ

[1] Bull. U. S. Nat. Mus. 100 (1925).

by 65 μ, oval. Of the above-mentioned fibers, the mesh, approximately square, is about 0.45 to 1 mm in diameter. The fibers are about 360 in diameter and are crowded with foreign material so that the spongin is scarcely evident. The fascicular nature of the specimen studied by Wilson is barely in evidence, but there can be little doubt that it is the same variety as the one found by that author near this locality.

This specimen is in general quite characteristic of *pallescens*, especially in the lavender color and the wide distribution of the conules. The other conspicuous member of the genus *Dysidea* is *D. fragilis*, which is a pale gray sponge lacking the lavender and having many small conules very close together, which are usually less than 1 mm high and less than 1 mm apart, apex to apex.

Remarks.—This species was described as *Spongelia pallescens* by Schmidt (1862, p. 29) in his monograph on the sponges of the Adriatic, and referred to *Spongelia* by Schulze (1879, p. 138). There may be some doubt that the Philippine sponge is conspecific with Schmidt's from the Mediterranean. Wilson (1925, p. 476) reported from the Philippine Islands a sponge which is clearly conspecific with that in the collection at present under discussion, and identified it as *Dysidea fragilis* var. *fasciculata* Wilson. Wilson explained that he employed the specific name in question rather than *pallescens* because Lendenfeld (1889, p. 642) had reduced *pallescens* in synonymy to *Spongia fragilis* of Montagu (1818, p. 114). But this is not a good reason. Hallmann [2] demonstrated conclusively that the latter author was utterly unreliable in his conclusions and descriptions.

ADOCIA BAERI (Wilson). Plate 1, fig. 1.

The Puerto Galera specimen is represented by some fragments, perhaps all from the same colony, which colony was presumably ramose. The fragments are cylindrical, usually hollow, and in one case dichotomously branched. The color as preserved in alcohol is dark, almost black. The consistency is very soft. The surface, as is very characteristic of *baeri*, is minutely tuberculate. A dermal region of specialized pigment cells extends some 400 μ into the sponge. The endosome is a typical "renierid" or isodictyal reticulation, with conspicuous canals about 1 mm in diameter, running longitudinally in the cylinders, parallel to the surfaces of the exterior and of the cloacal hollow.

[2] A Revision of the Monaxonid Species Described as New in Lendenfeld's Catalogue of the Sponges in the Australian Museum (1914).

There are what appear to be pores, remarkably large, even 1 mm in diameter in many cases. The oscule or cloacal aperture is terminal and 3 mm in diameter. The megascleres are rather sharp pointed oxeas, fairly uniform in size, 5 μ by 130 μ. Among them are considerable numbers of much smaller oxeas, only 0.5 μ by 90 μ. These are perhaps undeveloped megascleres of the principal type or, on the other hand, perhaps to be regarded as microscleres. Spicules, while not yet fully formed, are well known to resemble the fully formed ones in shape, except for much greater slenderness, and the presence of such spicules must therefore have very doubtful taxonomic value. It is always possible that they may represent a special category, but it can seldom be ascertained to any degree of satisfaction whether or not this is the case.

Remarks.—Wilson (1925, p. 398) reported from the Philippine Islands a specimen obviously conspecific with the present variety, which he identified as *Reniera implexa* Schmidt var. *baeri* Wilson (1868, p. 27). Burton[3] demonstrates the suitability of the genus *Adocia* rather than *Reniera* for cases such as the one under consideration; furthermore, the differences between the Philippine and the Mediterranean forms are sufficiently great for full specific rank. Within the genus under discussion there are so few criteria upon which to base specific differences that items which would appear trivial in other groups must here receive major attention.

GELLIODES FIBROSA (Wilson). Plate 1, fig. 2.

The Puerto Galera species here described is a small cavernous mass represented in places by only a series of trabeculæ each about 2 by 4 mm. As preserved in alcohol it is blue-gray on the exterior over a paler gray not at all blue on the interior. The consistency is quite spongy. The ectosomal specialization is a membranous sheet, transparent, and contains tangentially placed spicules. The endosome is very cavernous, with chambers 6 mm in diameter, elongate, meandering through the interior. The architecture is pronouncedly fibrous as is characteristic of the genus *Gelliodes* but not of the so-called *Gellius*. These fibers contain many spicule rows, and range from 60 μ to 160 μ in diameter. The mesh that they form is commonly 700 μ to 2,000 μ in diameter. There are auxiliary connectives which are fibers of only about half (or less) the diameter of the

[3] Sponges of the Great Australian Reef (1934).

principal ones, and these inclose meshes only 40 μ to 60 μ in diameter. The spicules are typically oxeas, but perhaps 3 to 5 per cent of them are styles. Typical sizes are 6 μ by 190 μ, 5 μ by 175 μ, 5 μ by 150 μ, 4 μ by 150 μ. Among these are sigmas of great variation in size and thickness; the length of chord varies from 11 μ to 22 μ, and the thickness from much less than to nearly 2 μ.

The cavernous structure is perhaps the most characteristic feature of this species as contrasted with others of the genus *Gelliodes*. The spicules are rather smaller than those of most, and the lack of conules also is noteworthy.

Remarks.—This sponge was described from the Philippines by Wilson (1925, p. 398) as being conspecific with the sponge first described as *Halichondria varia* by Bowerbank (1875, p. 292), and later referred to *Gellius* by Ridley and by other authors. Wilson established for the Philippine sponge a new variety, *fibrosa*. The present specimen sheds still further light on the nature of the species over and above the information available to Wilson, and it now becomes evident that instead of being a *Gellius* (*Adocia*), this is a *Gelliodes*. Therefore, it becomes necessary to treat the name *fibrosa* as of full specific rank instead of as a variety. It is not implied that *varia* of Bowerbank is also a *Gelliodes*, but rather that it is not even congeneric with the Philippine sponge.

LISSODENDORYX ROXASI sp. nov. Plate 1, fig. 3.

This Puerto Galera sponge is about 2 cm by 6 cm, an irregular reticulation of trabeculæ, very cavernous in nature. The color is drab, and the consistency is very elastic. Because of the cavernous, perhaps partially macerated condition, the pores and oscules cannot be described. A large amount of the dermis may have been lost. The reticulation made by the structures referred to above consists of meshes only some 2 mm apart, center to center, and nearly rectangular in outline. The trabeculæ themselves are nearly 1 mm in diameter. The ectosomal spicules are uncommon, many having perhaps been lost since the sponge was preserved. They are tylotes, 3 μ by 220 μ. The abundant principal spicules are crowded rather irregularly in the endosome. They are entirely spined styles, 8 μ by 155 μ. Many of them are so placed as to echinate the trabeculæ. There are two size ranges of arcuate isochelas. The abundant ones are about 36 μ long, but a rarer sort is only 16 μ long. Sigmas 70 μ in chord length are present, but not at all common.

Remarks.—Wilson (1925, p. 432) described a species of *Lissodendoryx*, from the Philippine Islands, naming it *tawiensis*. There is little reason to believe that this species is conspecific with the form under consideration. In fact, it is not even congeneric, especially since its chelas are not arcuate, but distinctly palmate. It is, therefore, here proposed to regard it as the genotype of a new genus to be known as Myxichela. The diagnosis would be, "resembling *Myxilla* except for the substitution of palmate chelas instead of any other kind." The nearest of the numerous species of *Lissodendoryx* to *roxasi* seems to be that described by Topsent (1897, p. 457) as *baculata*, from the East Indies. Of the latter, the dermal spicules are strongyles instead of tylotes, but of about the same size as those in *roxasi*. The principal megascleres are somewhat larger, and smooth. It has only the smaller size range of isochelas, and its more numerous sigmas are smaller.

The genus *Lissodendoryx* is very close to the genus *Myxilla* from which it was originally separated by having smooth principal spicules, whereas *Myxilla* has spiny megascleres. This fact by itself alone proved to be an untenable basis of differentiation, and it was noted that the genotype has this further significant difference, that its chelas are arcuate instead of anchorate, as in *Myxilla*, and this distinction has been recently accepted as the firm basis for differentiation. However, there are very few species of *Lissodendoryx* that possess spines upon the principal megascleres; the sponge now being described is one of the few presenting this characteristic.

The species described here is named in honor of Prof. Hilario A. Roxas, of the Bureau of Science, Manila.

MONANCHORA DIANCHORA sp. nov. Plate 1, fig. 4.

This Puerto Galera sponge was a lamellate mass about 1 cm thick, and 4 by 5 cm in area, curled in such a way as almost to make a funnel. Preserved in alcohol, it is light orange-red on the exterior and paler orange on the interior. The consistency is soft and spongy. The surface might perhaps be described as conulose, but there are only about a dozen conules on the entire surface, which is otherwise smooth. The conules in question are about 4 mm high. The dermal membrane is thin and can only with great difficulty be detached from the subdermal cavities which extend beneath it. In it the dermal spicules are tangentially placed. The endosome is very confused, but vague ascending tracts can be made out here and there,

consisting of approximately eight spicule rows each, and being about 40 μ in diameter. The megascleres are of one type only, namely tylostyles, but tend to be of two sizes. Those in the ectosome are approximately 4 μ by 283 μ. Typical sizes for those in the endosome may be given as 7 μ by 276 μ, 5 μ by 370 μ, 9 μ by 270 μ. The microscleres are most distinctive. There are two kinds, appearing superficially like sigmas, but being really unguiferate chelas having several teeth at each end. The commonest category is of isochelas of this type, 33 μ in chord length, and having at each end four sharp-pointed teeth. A second category is of similar spicules, only 20 μ in chord length and apparently having only three minute teeth at each end.

Remarks.—This sponge may be compared with *Monanchora clathrata* Carter (1883, p. 369), the type of the genus, which it resembles in general, except that Carter's species had at least five teeth at each end of the peculiar chelas. We do not have many data pertaining to the Australian species, there being little information available, for example, as to its flesh and structure in general. Another species of especial interest here is the one described by Dendy (1921, p. 58) as *Amphilectus unguiculatus,* from the Indian Ocean. Its megascleres are considerably longer but not thicker than those of *dianchora,* and its microscleres are very unusual in their flat, straplike shape, the shaft not being round in cross section as might be expected.

It is interesting to find another representative of this rare genus characteristic of the East Indian and Australian regions. It is somewhat paradoxical that Carter's choice of a generic name was most inappropriate. Whereas the Philippine species has more than one kind of "anchor," it is clearly so closely related to *clathrata* that it scarcely seems appropriate to establish for it at the present time a new genus, merely because it does not conform to the description implied in the generic name.

DRAGMAXIA CILIATA (Wilson). Plate 1, fig. 5.

The Puerto Galera sponge here described is a lobate mass about 7 by 3.5 by 3.5 cm. The surface is smoothly rounded into somewhat less than a dozen nearly spherical lobes. The color as preserved in alcohol is brown, darker on the exterior, and paler in the interior. The consistency, like that of the genus *Suberites,* is corklike. The surface, however, is pronouncedly hispid, with a spicule fur about 80 μ high consisting of spicules some 20 μ apart, placed erect; otherwise the surface

may be described as nearly smooth. There are numerous pores 28 μ to 40 μ in diameter, and about 80 μ to 90 μ apart, but the oscules cannot be made out with certainty. The endosome is pronouncedly radial, and very dense in structure, lacking the breadlike appearance frequently found in sponges of the Suberitidæ. The flagellate chambers are round, presumably diplodal, varying from 28 μ to 40 μ in diameter. The megascleres are styles. Those of the ectosome are only about 4 μ by 320 μ, a few being as much as 5 μ in diameter, but many only as thick as 2 μ. Those of the endosome are much larger, varying frequently between 22 μ by 930 μ and 26 μ by 1040 μ. Among them are very small spicules or rhaphides less than 1 μ in diameter and usually a little more than 200 μ in length.

Remarks.—Wilson (1925, p. 341) described this species from the Philippines as *Tuberella ciliata.* Topsent in 1900 in his "Etude monographique des Spongiaires de France" made clear that *Aaptos* and *Tuberella* were synonymous. The former dates from Gray (1867) and the latter only from Keller (1881), so it is evident that *Tuberella* should be dropped in favor of *Aaptos,* not vice versa. It appears that Wilson's specimen had few or none of the rhaphides, so *Dragmaxia* was not suggested.

The genus *Dragmaxia* has for a long time been represented exclusively by its genotype, the sponge described by Whitelegge (1907, p. 513) as *Spongosorites variabilis.* It is quite a pleasure to find another species for this rare and interesting genus. Whitelegge established the genotype with the understanding that his species was an epipolasid, that is to say, a reduced tetraxon sponge. Apparently Hallmann (1916, p. 543) was quite right when he transferred it (as of his new genus *Dragmaxia*) to the Axinellidæ. A still further interesting concept is brought out by comparison with the genus *Aaptos; Dragmaxia ciliata* is very much like *Aaptos,* except for its possession of oxeote microscleres. The latter genus is usually regarded as suberitid rather than axinellid. The dense subspherical shape of *ciliata* suggests a suberitid relationship, but its hispid ectosome points more forcibly toward the Axinellidæ. All items considered, this is not only an interesting but also a perplexing species.

Comparing this sponge with the other species of *Dragmaxia* mentioned above, that species (*variabilis*) is lamellate, and its principal spicules are nearly double the thickness without

being longer than those of *ciliata;* its microscleres are about five times as thick without being longer. A fairly close relationship is indicated. Another genus that is worthy of consideration here is *Alloscleria* Topsent, which, however, has two types of diactinal microscleres, one kind acanthoxeas, and the other centrotylote smooth oxeas.

SPIRASTRELIA VAGABUNDA Ridley. Plate 1, fig. 6.

The present Puerto Galera species is a compact mass 4 cm in diameter and 6 cm in height, showing pronounced vertical grooves on the lateral surfaces, so that it becomes almost digitate. In alcohol it is a rich brown, and the consistency resembles that of cork. The color is due to very strongly pigmented bodies contained in a layer of cells about 40 μ deep from the surface. In general the surface is to be described as smooth. No membrane can easily be removed from it. The structures in the interior are as confused as are those of the exterior, but more of the spicules have their points directed towards the surface of the sponge than in any other direction. There are no special dermal spicules. The megascleres are of one type only, namely tylostyles, of which the following sizes are representative: 13 μ by 570 μ, 14 μ by 540 μ, 16 μ by 594 μ, 14 μ by 634 μ, 9 μ by 405 μ. The microscleres are much bent or spiral spirasters with very small spines; the entire spicule averages little more than 1 μ in thickness, and the maximum length is about 15 μ.

Remarks.—Very numerous species of *Spirastrella* have been described from various parts of the world and they do not differ greatly from each other. Vosmaer in 1911 in connection with the *Siboga* reports, published a monograph on this genus, in which he reduced a very large number of species in synonymy to *Spirastrella purpurea.* It is here considered that Wilson's remarks in the 1925 reference mentioned above are correct; namely, that by no means all of the species mentioned by Vosmaer should be so reduced.

The sponge at present under consideration is obviously the same as that described by Wilson (1925, p. 343) with the above identification. This statement calls for some discussion, but little more need be said than what has already been written by Wilson in the reference cited. *Vagabunda* was established by Ridley (1884, p. 468), in his report on the Porifera collected by the *Sea Lark* in the Indian Ocean.

MYRIASTRA CLAVOSA (Ridley). Plate 1, fig. 7.

This Puerto Galera sponge is represented by a number of small spherical masses some 6 to 8 mm in diameter each. The color as preserved in alcohol is very pale brown, almost white, and the consistency is rather elastic but similar to cork. The cortical specialization is very thin for a tetraxon sponge of this nature, being only from 80 μ to 95 μ thick. It extends over very definite subdermal cavities. The endosomal structure is pronouncedly radial. Pores cannot be distinguished with certainty, and each of the small sponges seems to have just one oscule, which is about 1 mm in diameter. The principal spicules are large dichotriænes with their cladomes in or just below the cortex. They are frequently as long as 4 mm. The rhabds are about 50 mm in diameter, and the chord ranges from 570 μ to 660 μ. There are anatriænes, protriænes, and orthotriænes, as well as oxeas. The rhabds of the former, and the total diameter of the latter, are in the neighborhood of 18 μ. The chords of the triænes range from about 65 μ to nearly 100 μ. Microscleres seem to be of one sort only, namely tylasters. They vary from 9 μ to 15 μ in diameter, and (as usual among the tetraxon sponges) the smaller asters have the more numerous rays, up to fourteen or fifteen, whereas the larger have less numerous rays, only three to five.

Remarks.—This species was first described as *Steletta clavosa* by Ridley (1884, p. 474), in his report of the Indian Ocean sponges collected by the *Sea Lark*. A very complete and satisfactory discussion of it is given by Wilson (1925, p. 387).

GEODIA SPARSA Wilson.

The Puerto Galera sponge here described is a subspherical mass about 1 cm in diameter, light brown in color, and with a stony hard cortex. Underneath this the endosome is brittle but somewhat like cork in other ways. These characters are quite typical of the genus *Geodia*. The cortex is about 800 μ thick, and is densely packed with sterrasters as characteristic of the group. The pores and oscules cannot be distinguished. The endosome is pronouncedly radial in structure. The principal megascleres are plagiotriæna with rhabds about 20 μ by 1685 μ (a few being much longer), and with chords 265 μ across. In this specimen there occur also orthotriænes of which the rhabds appear always to have been broken. The clads are about 350 μ to 430 μ long. The sterrasters are approxi-

mately 108 μ by 121 μ, and, of course, developmental forms thereof occur. The euasters appear to have their arms microspined; they reach a diameter of approximately 12 μ to 16 μ. There are furthermore rather numerous spherasters, chiefly centrum, having a diameter of barely 4 μ.

Remarks.—This sponge was described as a new species from the Philippines by Wilson (1925, p. 314).

ILLUSTRATION

PLATE 1

[From camera-lucida drawings. Figs. 1 to 4 and 7, *e* are × 630; figs. 5, 6, and 7, *a* to *d* are × 150.]

FIG. 1. *Adocia baeri* (Wilson); *a*, oxeote megasclere; *b*, rhaphide.

2. *Gelliodes fibrosa* (Wilson); *a* and *b*, oxeas; *c*, sigmas.

3. *Lissodendoryx roxasi* sp. nov.; *a*, tylote; *b*, acanthostyle; *c*, sigma; *d*, larger (arcuate) chelas; *e*, smaller chelas.

4. *Monanchora dianchora* sp. nov.; *a*, tylostyle; *b*, larger (unguiferate) chelas; *c*, smaller chelas.

5. *Dragmaxia ciliata* (Wilson); *a*, endosomal style; *b*, ectosomal style; *c*, rhaphide.

6. *Spirastrella vagabunda* Ridley; *a*, tylostyle; *b*, spirasters.

7. *Myriastra clavosa* (Ridley); *a*, cladome of dichotriæne; *b*, cladome of plagiotriæne; *c*, protriæne; *d*, cladome of anatriæne; *e*, tylasters.

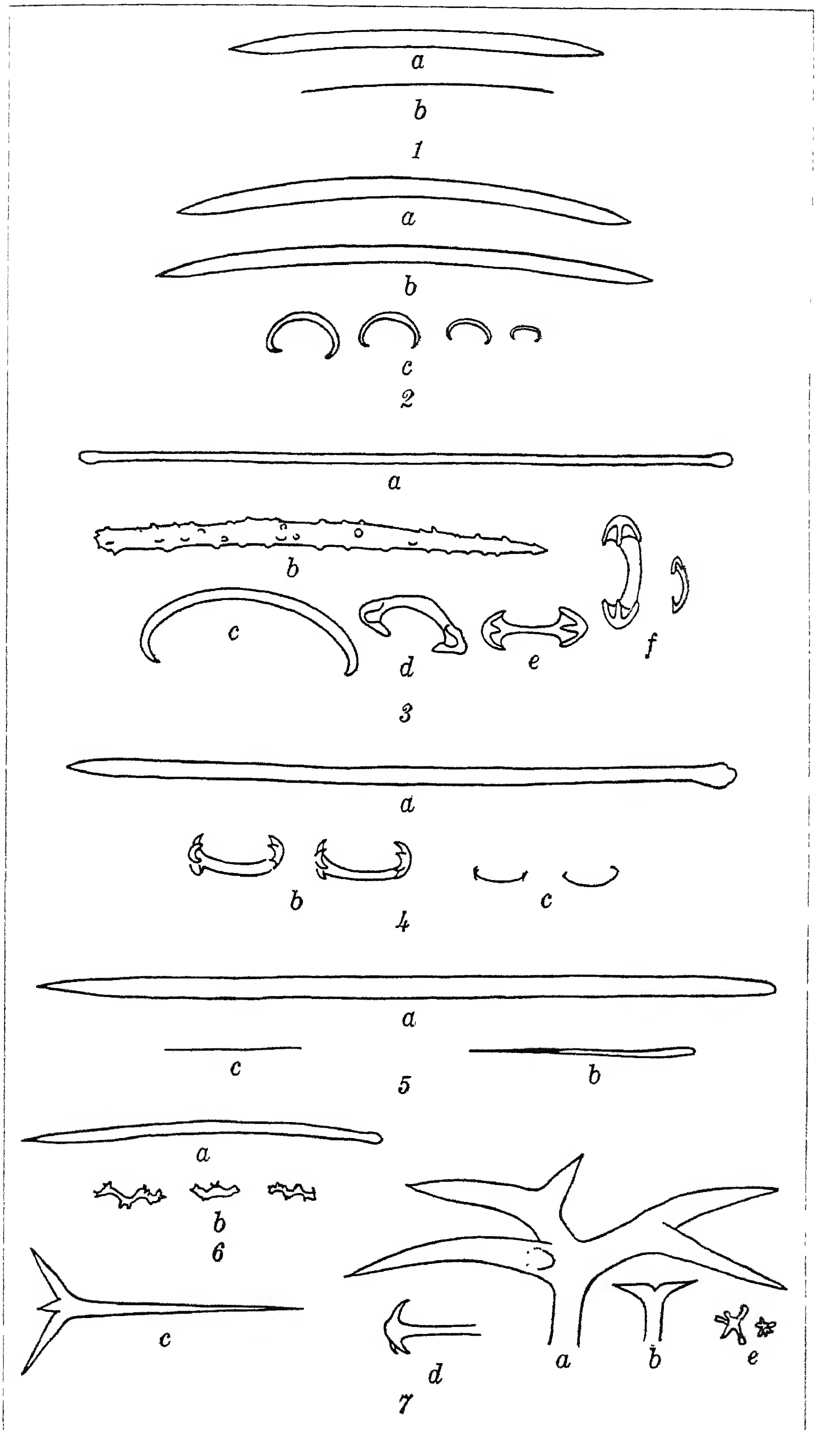

PLATE 1.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXIII [1]

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

THREE PLATES

The crane flies discussed in this paper are chiefly derived from three sources; namely, Celebes, collected by Mr. Charles F. Clagg; Formosa, by Mr. J. Linsley Gressitt; and Kashmir, by Miss Vivien R. Hutchinson. Scattered additional species were secured in Java by Dr. Ian Mackerras; in Formosa by Prof. Syûti Issiki; and on Mount Omei, western China, by the Rev. Mr. George M. Franck. One further species, from eastern Siberia, was included in the rich collections belonging to the Russian Academy of Sciences, Leningrad, sent to me for study by Dr. A. von Stackelberg. I wish to express my deepest thanks to all of the above-named entomologists for their continued kindly coöperation in my study of the Tipulidæ of Asia. Except where indicated to the contrary, types of the various novelties are preserved in my collection. As has been done in other parts under this series of reports, I am including a species of Trichoceridæ, preferring this course to preparing a special paper on this insect.

TRICHOCERIDÆ

TRICHOCERA ARISANENSIS sp. nov. Plate 1, fig. 1.

General coloration of thorax brownish yellow, the præscutum with three darker brown stripes; pleura chiefly dark brown, variegated by paler brown; femora brown, their bases obscure yellow; wings yellowish gray, sparsely patterned with brown; abdominal segments conspicuously bicolorous, the basal portion brown, the outer ring light yellow.

Female.—Length, about 6 millimeters; wing, 6.5.

Rostrum dark brown; palpi elongate, brownish black. Antennæ black, the scape and pedicel paler; outer flagellar segments

[1] Contribution from the entomological laboratory, Massachusetts State College.

paler than the basal ones; flagellum much more elongate and much slenderer than in *pictipennis,* the individual segments correspondingly lengthened. Head brown.

Mesonotal præscutum brownish yellow with three darker brown stripes; scutal lobes dark brown, the median area more yellowish; scutellum and mediotergite more testaceous brown. Pleura chiefly dark brown, variegated by paler brown on the pteropleurite and posterior anepisternum; dorsopleural membrane yellow. Halteres pale yellow, the knobs dark brown. Legs with the coxæ and trochanters yellowish testaceous; femora obscure yellow basally, passing into brown outwardly; tibiæ and tarsi brown. Wings (Plate 1, fig. 1) with the ground color yellowish gray, sparsely patterned with brown, including areas at origin of Rs, along cord, on vein R_2, outer end of cell 1st M_2, and the fork of vein M_{1+2}; paler and less evident areas in the outer radial field; no darkening at end of vein 2d A; veins brown. Venation: R_{2+3+4} a little shorter than R_{1+2}; Sc_1 ending about opposite fork of R_{2+3+4}; cell M_1 subequal to or a little longer than its petiole; m-cu shortly before fork of M_{3+4}; vein 2d A somewhat angular, at extreme outer end bent suddenly into margin.

Abdominal segments conspicuously bicolorous, the basal two-thirds of the individual segments brown, the outer third light yellow. Cerci pale yellow, the tips acute.

Habitat.—Formosa.

Holotype, female, Arisan, altitude 7,640 feet, May 24, 1934 (*Gressitt*).

The nearest allied species is *Trichocera pictipennis* Alexander, of Japan and Korea, which differs conspicuously in the coloration of the thorax and abdomen, in the shorter antennæ, and in the details of the wing pattern. The genus *Trichocera* is new to the fauna of Formosa.

TIPULIDÆ

TIPULINÆ

LONGURIO (LONGURIO) VARICEPS sp. nov. Plate 1, fig. 2.

General coloration of thorax black; head fulvous-orange, with a conspicuous black longitudinal stripe on either side of vertex; halteres and legs black throughout; wings strongly tinged with black, the costal portion and seams along vein Cu and anterior cord still darker; Rs short, a little less than cell 1st M_2; abdomen with segments six to nine, inclusive, black; tergites two to five

orange, narrowly bordered by blackish; basal sternites conspicuously bicolorous, black, variegated by yellow.

Male.—Length, about 21 millimeters; wing, 16.5; abdomen alone, 16.5.

Female.—Length, about 25 millimeters; wing, 18; abdomen alone, 20.

Rostrum and palpi velvety black. Antennæ black throughout; outer verticils very long and conspicuous. Head dull fulvous-orange, with a conspicuous black longitudinal stripe extending from either side of the vertical tubercle along the orbital region, behind becoming more diffuse and involving the occipital region, leaving the median area of the posterior vertex of the ground color.

Thoracic dorsum and pleura entirely deep velvety black. Halteres and legs black throughout. Wings (Plate 1, fig. 2) very strongly tinged with black, the prearcular region, cells C and Sc, stigma, and seams along vein Cu and on anterior cord darker; paler longitudinal streaks in cells R, M, and 1st A in female sex; veins black. Venation: Rs shorter than cell 1st M_2 and a little longer than m-cu.

Abdomen with basal segment velvety black; tergites two to five, inclusive, orange, narrowly bordered on the lateral and caudal portions by black; succeeding tergites and hypopygium black; basal sternites conspicuously bicolorous, black, variegated more extensively on sides of basal ring with yellow, less extensively and distinctly on outer ring just before apex.

Habitat.—Formosa.

Holotype, male, Hori, altitude 2,340 feet, June 7, 1934 (*Gressitt*).

Allotopotype, female. Paratopotype, female.

The nearest ally is *Longurio* (*Longurio*) *rubriceps* Edwards, likewise from Formosa, which differs in the coloration of the head, legs, and pattern of the basal abdominal sternites, and in the elongate Rs.

TIPULA (ACUTIPULA) ALBOPLAGIATA sp. nov. Plate 1, fig. 3; Plate 2, figs. 25, 26.

Allied to *Tipula* (*Acutipula*) *munda;* antennal flagellum weakly bicolorous, the basal enlargements of the individual segments a trifle darker than the remainder; pleura yellow; legs black; wings very strongly tinged with brown, variegated by a whitish obliterative area before cord and by a pale yellow longitudinal streak behind vein Cu; abdomen yellow, the outer segments brownish black; male hypopygium with tergal lobe

bifid; inner dististyle with outer lobe terminating in a very slender, acute spine; eighth sternite fringed with yellow setæ.

Male.—Length, about 17 millimeters; wing, 19.5.

Frontal prolongation of head brown; nasus dark brown, conspicuous; palpi black. Antennæ with scape and pedicel dark brown; flagellum very weakly bicolorous, the basal enlargement a trifle darker brown than the remainder. Head dark brownish gray.

Pronotum uniformly reddish brown. Mesonotal præscutum gray, with four more olive-gray stripes that are poorly defined against the ground, the stripes feebly delimited by very narrow darker borders; scutal lobes brownish gray, the median region more yellowish; posterior sclerites of mesonotum chiefly yellow pollinose. Pleura yellow, the pleurotergite gray pruinose. Halteres brownish black throughout. Legs with the coxæ and trochanters yellow; remainder of legs black, excepting only the very narrow femoral bases which are yellow. Wings (Plate 1, fig. 3) very strongly tinged with brown, the prearcular region and cells C and Sc even darker brown; stigma small, yellow; ground color variegated by a conspicuous whitish obliterative area before the cord, extending from the proximal end of the stigma into cell 1st M_2 but not or scarcely invading cell M_3; a conspicuous, pale yellow, longitudinal stripe extending almost the entire length of wing immediately behind the basal section of vein Cu_1, involving cell Cu_1 and the adjoining portion of cell Cu; veins dark brown. Macrotrichia of veins sparse; squama with setæ. Venation: Petiole or cell M_1 shorter than m.

Abdomen yellow, the tergites with a narrow, brown, sublateral border; segments six to nine, inclusive, more uniformly brownish black. Male hypopygium (Plate 2, fig. 25) with the ninth tergite (Plate 2, fig. 26, 9*t*) narrowed at outer end into a depressed yellow lobe, the apex of which has a deep U-shaped median notch, the slender lobes thus formed set with blackened spines. Outer dististyle, *od,* flattened, relatively narrow, the outer margin nearly straight, the inner one evenly curved. Inner dististyle, *id,* with the outer lobe terminating in a very slender, acute spine; inner lobe darkened, simple, the apex obtuse. Eighth sternite (Plate 2, fig. 26, 8*s*) with the caudal margin transverse, fringed with yellow setæ, those at the outer lateral portions a little longer and slightly stouter.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,640 feet, May 24, 1934 (*Gressitt*).

Tipula (*Acutipula*) *alboplagiata* is very different from other regional members of the *munda* group in the black legs, darkened wings, and structure of the male hypopygium, especially of the inner dististyle which is distinct from that of all other described species known to me.

TIPULA (SCHUMMELIA) INDIFFERENS sp. nov. Plate 1, fig. 4; Plate 2, figs. 27, 28.

Belongs to the *continuata* group; antennæ with flagellar segments unicolorous; mesonotal præscutum obscure brownish yellow, with three brownish gray stripes, the median one divided by a capillary blackish line; knobs of halteres chiefly light yellow; wings grayish brown, the stigma dark brown; restricted paler brown clouds in outer end of cell 1st M_2, on m-cu, and on distal section of Cu_1; squama naked; abdomen orange, segments six to nine uniformly black.

Male.—Length, 12 to 13 millimeters; wing, 13 to 14.5.

Frontal prolongation of head dark brown above, paling to yellow beneath and on sides; nasus elongate. Antennæ (male) of moderate length, if bent backward extending about to middistance between the bases of the wings and halteres; scape and pedicel yellow; basal two or three flagellar segments brownish yellow, the succeeding segments passing into black; verticils a little longer than the segments. Head brownish gray, more or less pruinose.

Mesonotal præscutum obscure brownish yellow, with three brownish gray stripes, the median one divided by a capillary more-blackish line; lateral stripes vaguely bordered by darker, especially along their mesal edge; centers of scutal lobes darkened; scutellum infuscated basally, margined with yellow; postnotum yellow. Pleura chiefly yellow or brownish yellow, the pleurotergite darker and weakly pruinose. Halteres dusky, the base of stem obscure yellow, the knob chiefly light yellow. Legs with the coxæ and trochanters yellow; femora obscure yellow, before the tips narrowly blackened, the extreme apices restrictedly pale; tibiæ brown, the tips slightly darker; tarsi black. Wings (Plate 1, fig. 4) with the ground color grayish brown, very weakly patterned with darker; stigma oval, dark brown; paler brown clouds across outer end of cell 1st M_2, along m-cu and outer section of vein Cu_1; obliterative area extensive, from the outer end of cell R into base of cell M_3; veins dark brown. Squama naked. Venation: R_{1+2} entire but without trichia except at base; Rs shorter than m-cu; petiole of cell M_1 shorter than m.

Abdomen orange, the pleural region narrowly dusky; segments six to nine uniformly black, only the outer dististyle pale yellow. Male hypopygium (Plate 2, fig. 27) with the caudal border of the tergite (Plate 2, fig. 28, *9t*) deeply emarginate, blackened, fringed with delicate yellow setæ. Outer dististyle, *od*, slightly flattened, narrowed outwardly, the tip obtuse. Inner dististyle as shown (Plate 2, fig. 28, *id*) ; setæ of outer margin approximately 20 in number.

Habitat.—Kashmir.

Holotype, male, Srinagar, altitude 5,000 feet, June 9, 1934 (*Miss Hutchinson*). Paratopotype, male; paratypes, 3 males, Kaj-Nag Range, altitude 8,000 feet, May 30 to June 1, 1934.

Tipula (*Schummelia*) *indifferens* is very distinct from the other regional members of the subgenus in the almost unpatterned wings and the conspicuous coloration of the abdomen. The nearest allies would seem to be *continuata* Brunetti and *xanthopleura* Edwards, both with a very distinct pattern of the wings and abdomen.

TIPULA (SCHUMMELIA) NIGROCELLULA sp. nov. Plate 1, fig. 5; Plate 2, fig. 29.

Belongs to the *continuata* group; præscutal stripes distinct, narrowly bordered by darker brown; thoracic pleura striped longitudinally with brown; knobs of halteres extensively yellow; femora with a narrow, nearly terminal, black ring; wings whitish subhyaline, with a conspicuous brown pattern; cell Sc uniformly blackened; cell 2d A yellow, variegated by two dark clouds; squama naked; abdominal tergites reddish, narrowly lined with darker; a subterminal black ring on abdomen; male hypopygium with the caudal margin of tergite tridentate; basistyles bearing conspicuous pencils of reddish setæ.

Male.—Length, 12 to 13 millimeters; wing, 12.5.

Female.—Length, 17 to 19 millimeters; wing, 15 to 16.

Frontal prolongation of head yellow above and beneath, narrowly darkened on sides; nasus elongate, yellow. Antennæ (male) of moderate length, if bent backward extending approximately to wing root; scape and pedicel light yellow; flagellar segments dark brown, the extreme outer end of the individual segments a trifle paler; longest verticils subequal to the segments. Head brownish yellow, clearer yellow on anterior vertex; a narrow brownish median line.

Mesonotal præscutum yellow, with three conspicuous brown stripes that are narrowly bordered by darker brown, the median one further divided by a dark vitta; scutal lobes chiefly covered

by brown areas, the median region of scutum pale; scutellum and mediotergite chiefly darkened medially, paler laterally. Pleura yellow, conspicuously striped longitudinally with dark, including a dorsal stripe extending from the propleura across the ventral anepisternum, and a more interrupted, fainter area on the ventral sternopleurite and meron. Halteres with the stem obscure yellow, a little brighter at base; base of knob brown, the apex conspicuously light yellow. Legs with the coxæ and trochanters pale yellow; femora brownish yellow, immediately before tip with a narrow black ring; tibiæ brown, paler basally, blackened outwardly; tarsi black. Wings (Plate 1, fig. 5) whitish to pale yellow subhyaline, handsomely patterned with brown; prearcular region and cell C clearer yellow; cell Sc uniformly blackened, excepting the yellow extreme outer end; stigma dark; the dark discal pattern includes conspicuous clouds across m-cu and fork of Cu; at near midlength of cell M, and at outer end of cell 1st M_2, together with the adjoining veins; outer radial cells weakly washed with brown; cell 2d A yellow, conspicuously variegated by a dark cloud at end and by another at midlength of margin; veins dark, except in the obliterative area. Squama naked. Venation: R_{1+2} entire; petiole of cell M_1 subequal to or shorter than m.

Abdominal tergites chiefly reddish, the sternites more yellow; tergites narrowly and inconspicuously lined medially and laterally with black; a black subterminal ring, involving tergites six to nine and sternites seven and eight; remainder of the hypopygium yellow. Male hypopygium with the tergite (Plate 2, fig. 29, 9*t*) transverse, the emarginate caudal end tridentate, with smaller blackened teeth on either side, directed mesad, together with a paler median tooth. Region of basistyle, on either side, with a pencil of reddish setæ, directed ventrad. Outer dististyle relatively long and slender, subterete, narrowed gradually to the apex. Ninth sternite on either side of ventral portion, immediately caudad of the margin of the eighth sternite, produced ventrad into a reddish fingerlike lobe.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 8,000 feet, June 1, 1934 (*Miss Hutchinson*). Allotopotype, female. Paratopotypes, 1 male, May 25, 1934; 1 male, 1 female, altitude 9,000 feet, May 30 to June 3, 1934.

The present species is readily told from all other regional members of the subgenus by the uniformly blackened subcostal cell and by the rather peculiar structure of the male hypopygium.

TIPULA (SCHUMMELIA) INDISCRETA sp. nov.

Female.—Length, about 17 millimeters; wing, 15.5.

Generally similar to *T.* (*S.*) *nigrocellula* sp. nov., differing in several important details.

Nasus short and stout. Antennæ with scape brownish yellow. Squama with setæ. Wings with cell Sc light yellow, concolorous with cell C; outer two-thirds of cell 1st M_2 abruptly darkened; cell M_1 conspicuously pale; dark seam along m-cu scarcely invading cell M_4; cell 2d A uniformly suffused with pale brown.

Compared with *T.* (*S.*) *continuata* Brunetti, which likewise has a group of setæ on the squama, the present fly differs conspicuously in the coloration of the antennæ and body, and in the venation and wing pattern, especially the much longer Rs, which is somewhat longer than m-cu and nearly twice as long as R_{2+3}; elongate cell 1st M_2, with the second section of vein M_{1+2} nearly two-thirds as long as vein M_1; and in the broader cell M_4.

Habitat.—Kashmir.

Holotype, female, Kaj-Nag Range, altitude 8,000 feet, June 1, 1934 (*Miss Hutchinson*).

TIPULA (LUNATIPULA) TRIALBOSIGNATA sp. nov. Plate 1, fig. 6; Plate 2, figs. 30, 31.

Antennæ bicolorous; mesonotal præscutum with ground color yellow pollinose, narrowly or obsoletely striped with darker yellow; wings grayish, variegated with darker gray and whitish areas, including a broad, incomplete, poststigmal fascia; a dark spot in cell Cu, preceded and followed by whitish areas; abdomen yellow, in the female with the tergites narrowly trilineate with darker yellow; male hypopygium with the basistyle produced caudad into a subobtuse chitinized point; eighth sternite with caudal brush of long yellow setæ.

Male.—Length, about 15 millimeters; wing, 15.5.

Female.—Length, about 20 millimeters; wing, 18.5.

Frontal prolongation of head brownish yellow above, darker laterally; nasus distinct. Antennæ (male) of moderate length, if bent backward extending to the wing root or shortly beyond; scape and pedicel yellow; flagellar segments bicolorous, brownish black basally, the outer end yellow, narrowly so on the first flagellar segment; outer flagellar segments more uniformly darkened. Head brownish yellow.

Mesonotal præscutum with the ground color yellow pollinose, with four narrow brown stripes that represent the lateral stripes and posterior outer borders of the usual median stripe; in male,

præscutal stripes obsolete or nearly so; scutal lobes more or less variegated with darker color; scutellum and mediotergite yellow. Halteres yellow, the knobs infuscated. Legs with the coxæ and trochanters yellow; femora obscure yellow to brownish yellow, the tips narrowly dark brown, preceded by a slightly clearer, more yellowish ring; tibiæ and basitarsi obscure yellow, the tips narrowly dark brown; outer tarsal segments dark brown. Wings (Plate 1, fig. 6) with the ground color grayish, variegated by pale and darker areas; the white markings include one before stigma; a broad poststigmal fascia, extending from margin to cell 1st M_2, and an obliterative streak across base of cell 1st M_2, extending from cell R into bases of cells M_3 and M_4, usually disconnected from the poststigmal fascia but, in cases, confluent; additional white areas on either side of a dark cloud in cell Cu; the dark areas include the stigma and a confluent area along cord, together with the dark spot in cell Cu above described; narrow and less evident dark seams on posterior cord and outer end of cell 1st M_2; veins brown to brownish yellow. Macrotrichia of veins small and relatively sparse; squama with sparse setæ. Venation: R_{1+2} entire; petiole of cell M_1 shorter than m.

Abdomen entirely yellow or orange-yellow; in female, with indications of three narrow brown tergal stripes. Male hypopygium (Plate 2, fig. 30) with the tergite chiefly separated from the sternite. Ninth tergite (Plate 2, fig. 31, *9t*) extensive, the caudal margin terminating in two small acute points that are separated from one another by a very shallow emargination; as in *Vestiplex*, these points are the dorsal manifestation of a tergal saucer that has swung caudad and ventrad so as to lie on the lower surface of the tergite. Basistyle, *b*, entire, the outer end produced into a subobtuse chitinized point; ventral portion with an oval lobe set with long yellow setæ. Outer dististyle slender, pale, from a slightly enlarged base. Inner dististyle, *id*, with the outer margin heavily blackened and corrugated. Eighth sternite, *8s*, with a dense brush of long yellow setæ but without lobes or other armature. Ovipositor with the cerci rather stout, smooth-margined.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 9,000 feet, June 3, 1934 (*Miss Hutchinson*). Allotopotype, female. Paratopotypes, 1 male, 1 female.

The darkened cloud in cell Cu is suggestive of the condition found in many species of *Acutipula* and other subgeneric groups of *Tipula*, but the present fly seems correctly referrable to *Luna-*

tipula. The wing pattern and the structure of the male hypopygium, especially the basistyle, readily separate the species from other described Himalayan members of the genus.

TIPULA (OREOMYZA) ARISANENSIS Edwards. Plate 2, figs. 32, 33.

Tipula arisanensis EDWARDS, Ann. & Mag. Nat. Hist. IX 8 (1921) 109–110.

The types, two females, were from Arisan, Formosa, collected May 24, 1917, by Shiraki. One male, from Pianan-ambu, Formosa, May 11, 1932, collected by Gressitt, seems undoubtedly to belong to this species and is described herewith as allotype.

The male hypopygium is of rather remarkable construction, much as in *Tipula foliacea* Alexander, yet with the details quite distinct.

Ninth tergite (Plate 2, fig. 32) very large and massive, fused with the sternite on basal half, the outer half indicated by a gently curved suture; lateral tergal arms produced into powerful flattened blades that extend caudad about as far as the level of the tips of the inner dististyle; median area of tergite with two low, triangular points. Viewed from the side (Plate 2, fig. 33) the tergal blades are seen to be strongly decurved, narrowed outwardly, with a shallow notch close to tip.

Male.—Length, about 9.5 millimeters; wing, 11.5.

Allotype, male, Pianan-ambu, Formosa, May 11, 1932 (*Gressitt*).

In *T. foliacea* the tergal blades are much longer, extending far beyond the level of the dististyles; the intermediate lobes of the tergite are obtusely rounded.

TIPULA GRESSITTI sp. nov. Plate 1, fig. 7; Plate 2, fig. 34.

General coloration gray, the præscutum with four dark brownish gray stripes; antennæ (male) relatively elongate, bicolorous; front silvery white; tips of femora broadly black; wings gray, variegated by yellow and darker areas; male hypopygium very small and of simple structure; ovipositor with short, fleshy valves.

Male.—Length, 9 to 10 millimeters; wing, 13; antenna, 4.

Female.—Length, about 9 to 10 millimeters; wing, 11.

Frontal prolongation of head dark brown, sparsely pruinose; nasus long and conspicuous, tufted with black setæ; palpi black. Antennæ (male) elongate, the thirteenth segment microscopic; antenna approximately as long as the combined head and thorax; scape and pedicel yellow; first flagellar segment yellow, weakly darkened at base; succeeding segments conspicuously bicolorous,

the basal enlargement black, the remainder yellow; outer segments more obscure but all except the twelfth retaining the bicolorous appearance; verticils a little shorter than the segments. Head with the front silvery white; anterior vertex and orbits yellow; disk of vertex more infumed, variegated by an elongate brown area on either side of the median furrow, the inner ends of the marks dilated, the narrow outer portion paralleling the orbits; an additional smaller dark spot immediately behind each antennal fossa.

Mesonotum gray, the præscutum with four dark brownish gray stripes, the intermediate pair separated only by a capillary line; scutum dark brownish gray, the anterior portion darkened by a posterior prolongation of the lateral præscutal stripes; posterior sclerites of mesonotum blackened, sparsely pruinose. Pleura black, heavily pruinose, more heavily so on ventral sternopleurite; dorsopleural membrane obscure yellow. Halteres chiefly pale yellow, darkened only by abundant black setæ near base of club. Legs with coxæ brownish gray, paler apically; trochanters yellow; femora obscure brownish yellow, the tips broadly and conspicuously blackened; tibiæ and tarsi brownish black to black; tibial spur formula apparently 1–1–2. Wings (Plate 1, fig. 7) with the ground color gray, variegated by brown and yellow areas; prearcular region and cell Sc yellow; cell C uniformly infuscated; stigma dark brown; a distinct brown cloud on anterior cord; the yellow color includes areas before and beyond stigma; near base and near outer end of cell M; near outer ends of cells M_1 to M_4, inclusive; most of cell Cu and areas in cell 1st A; cell 2d A more uniformly darkened; veins brown. Squama naked; macrotrichia of veins relatively long and numerous. Venation: R_{1+2} entire; petiole of cell M_1 variable in length, in the allotype nearly lacking so that cell M_1 is subsessile; cell 2d A relatively narrow.

Abdomen brown, the basal two tergites variegated with obscure yellow; lateral margin of second tergite blackened; hypopygium dark. Male hypopygium (Plate 2, fig. 34) very small and of simple structure, among the most generalized so far discovered in the genus. Ninth tergite separated from the fused sternite-basistyle; suture between basistyle and sternite indicated beneath, the former region extensive. Ninth tergite, *9t*, transverse, the caudal margin with a broad shallow emargination, the lateral lobes obtuse, with abundant normal setæ. Outer dististyle, *od*, broadly flattened, the apex obtuse. Inner disti-

style, *id*, simple, the apical beak very long and slender. Eighth sternite simple, weakly sheathing, the outer end membranous but with abundant setæ. Ovipositor with short fleshy valves.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,640 feet, May 24, 1934 (*Gressitt*). Allotopotype, female. Paratopotypes, 2 males, 1 female.

Tipula gressitti is named in honor of the collector, who has secured many interesting Tipulidæ in the high mountains of Formosa. I cannot place the fly in any of the now numerous subgenera of the vast genus *Tipula*. The Eastern Nearctic *Nobilotipula* Alexander has an ovipositor of somewhat similar structure, but the present fly scarcely seems to be consubgeneric. In its general appearance, especially in body coloration and wing coloration, the species bears a considerable resemblance to several other regional members of the subgenera *Acutipula, Lunatipula, Oreomyza,* and *Vestiplex,* but in the details of structure is very distinct.

NEPHROTOMA ATROLATERA sp. nov. Plate 1, fig. 8.

Mesonotal præscutum with the central portion largely covered by a shield-shaped pearly area that is margined in front and on sides by a velvety-black border; scutellum and mediotergite light yellow; pleura yellow; abdominal tergites yellow, trilineate with dark brown; sternites uniformly orange-yellow.

Female.—Length, about 14 millimeters; wing, 13.5.

Frontal prolongation of head light sulphur yellow; nasus with long black setæ; mouth parts more fulvous; palpi dark brown. Antennæ with basal segments brownish yellow, the flagellum passing into darker brown. Front light sulphur yellow; posterior portion of head dark orange, more yellowish behind but without evident occipital brand.

Pronotum entirely light sulphur yellow. Mesonotal præscutum with three confluent pearly stripes, the shield-shaped area thus formed bordered by velvety black, including a narrow cephalic border, broader lateral margins, and a deep triangular invasion of the humeral field; scutum with centers of lobes pearly, narrowly but completely bordered by velvety black; median region of scutum yellow; scutellum and mediotergite light sulphur yellow, with a narrow transverse dark line separating the two; mediotergite with numerous short black setæ. Anterior lateral pretergites sulphur yellow. Pleura yellow. Halteres dusky, the knobs yellow. Legs with the coxæ and trochanters light yellow; femora and tibiæ light brown, the tips weakly darkened; tarsi

black. Wings (Plate 1, fig. 8) somewhat teneral in the unique type, subhyaline; stigma and a seam along the cord narrowly darker; veins brown. Venation: Cell M_1 broadly sessile; m-cu uniting with M just before departure of vein M_4.

Abdominal tergites yellow, conspicuously trilineate with dark brown, the stripes entire or virtually so; sternites orange-yellow, the caudal borders of the segments restrictedly paler yellow.

Habitat.—Formosa.

Holotype, female, Hassensan, altitude 4,875 feet, June 22, 1934 (*Gressitt*).

The present fly is amply distinct from other described species of the genus in the pattern of the mesonotal præscutum and scutum. The presence of short, dense, black setæ on the postnotal mediotergite reminds one of *Nephrotoma medipubera* Edwards (eastern Java), which is otherwise a very different fly.

DOLICHOPEZA (NESOPEZA) LUGUBRIVESTIS sp. nov. Plate 1, fig. 9; Plate 2, fig. 35.

General coloration dark brown, the præscutum with three more-glabrous, somewhat nacreous stripes; pleura dark brown; legs black, only the outer tarsal segments restrictedly yellowish white; wings with the ground color strongly blackened; stigma darker, preceded and followed by whitish areas; Rs short, a little less than m-cu; male hypopygium with the lateral lobes of the tergal plate broadly rounded; gonapophyses long and conspicuous, the tips acute.

Male.—Length, about 12 millimeters; wing, 13.

Frontal prolongation of head brown; palpi black. Antennæ of moderate length, if bent backward extending approximately to base of abdomen; scape and pedicel brownish yellow, flagellum black; verticils abundant, the longest on the upper face and well scattered over the length of the segment. Front and vertical tubercle brownish yellow, the posterior portions of head more uniformly dark brown.

Mesonotal præscutum dull dark brown, with three more-glabrous, nacreous stripes, the median one broad and well defined, the lateral pair less clearly delimited; posterior sclerites of notum dark brown, the median area of scutum and mediotergite paler. Pleura dark brown, the dorsopleural region paler. Halteres with the stem dusky, narrowly obscure yellow at base, the knobs dark brown. Legs with the coxæ dark brown, paler apically; trochanters obscure yellow; femora and tibiæ black, the former restrictedly paler at base; tarsi black basally, the outer segments narrowly and restrictedly yellowish white, more ex-

tensively so on the posterior legs where the brightening involves about the outer two-thirds of the second tarsal segment and the succeeding segments; on the anterior legs the bright color of the tarsi is even more obscured. Wings (Plate 1, fig. 9) with the ground color strongly blackened, the stigma even darker, preceded and followed by whitish areas; a restricted darkened cloud on anterior cord; veins brownish black. Venation: Rs short, a little less than m-cu; medial forks of moderate depth.

Abdominal tergites dark brown, the incisures restrictedly more blackened, outer segments, including hypopygium, more uniformly blackened. Male hypopygium (Plate 2, fig. 35) with the lateral lobes of the tergal plate, *9t*, broad, their caudal margins broadly rounded. Ædeagus and subtending apophyses, *g*, very long and conspicuous, as illustrated; apophyses at base with a small cylindrical lobe but beyond this point simple, the tips acute.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,475 feet, May 25, 1934 (*Gressitt*).

Dolichopeza (*Nesopeza*) *lugubrivestis* is most nearly allied to *D.* (*N.*) *idiophallus* (Alexander) and *D.* (*N.*) *tarsalba* (Alexander), differing from both in the coloration of the body and wings, the venation, especially the short Rs, and the details of structure of the male hypopygium.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) SUBHOSTILIS sp. nov. Plate 1, fig. 10; Plate 3, fig. 36.

General coloration brown, the præscutal stripes not or scarcely indicated; antennæ black throughout; each of the outer flagellar segments with a single very long verticil, these unilaterally arranged; outer flagellar segments gradually increasing in length to the last; halteres elongate; legs brown, the femoral tips not brightened; wings broad, suffused with gray; stigma lacking; Sc_2 and R_{1+2} both very long; male hypopygium with a single dististyle, this terminating in a slender apical beak.

Male.—Length, about 10 millimeters; wing, 11.8.

Rostrum brown; palpi dark brown. Antennæ dark brown throughout; outer flagellar segments with a single verticil of unusual length, placed on outer face near base, this seta approximately twice the length of the segment bearing it; remain-

ing verticils relatively small and insignificant; flagellar segments beyond midlength of organ becoming progressively more elongate, the terminal segment longest. Head dark brown.

Mesonotum almost uniformly medium brown, the surface polished; præscutal stripes not or scarcely defined, the lateral pair indicated chiefly by a slightly darkened lateral portion. Pleura testaceous-brown. Halteres unusually long and slender, dark brown. Legs with the coxæ and trochanters brown; remainder of legs medium brown, the femoral bases not or scarcely brightened; claws with a long slender spine at near midlength, with a second smaller, more basal tooth. Wings (Plate 1, fig. 10) broad, almost uniformly suffused with gray; stigma not or scarcely indicated; veins brown. Macrotrichia of veins relatively long and conspicuous, on all longitudinal veins beyond cord, extreme distal end of vein 1st A and outer two-thirds of 2d A. Venation: Sc_2 very long, as in *hostilis*, several times as long as Sc_1 and considerably longer than R_2; R_{1+2} elongate; cell 1st M_2 wide; m-cu close to fork of M.

Abdomen dark brown; hypopygium somewhat paler. Male hypopygium (Plate 3, fig. 36) with the tergite, *9t*, narrowed outwardly, the apex abruptly thin and glabrous, with a U-shaped median notch, the lateral lobes thus formed low and subtruncate. Dististyle, *d*, single, its apical beaklike portion unusually slender. Gonapophyses, *g*, with the mesal-apical lobe broad. Ædeagus broad at apex.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,312 feet, May 27, 1934 (*Gressitt*).

The nearest described ally of the present fly is undoubtedly *Limonia* (*Limonia*) *hostilis* Alexander (Szechwan-Tibet border, at high altitudes), which differs conspicuously in the abruptly yellow tips of the femora and in slight details of venation and body coloration.

LIMONIA (DICRANOMYIA) TRANSFUGA sp. nov. Plate 1, fig. 11.

Mesonotal præscutum with a broad median brown stripe, the lateral borders of the sclerite broadly golden yellow; pleura pruinose; knobs of halteres dark brown; femora blackened at tips, the fore femora more extensively so; wings tinged with yellow, sparsely patterned with brown; abdomen with basal six segments orange-yellow, the remaining outer segments black.

Female.—Length, about 9.5 millimeters; wing, 10.

Rostrum brown, sparsely pruinose; palpi black. Antennæ black throughout; basal flagellar segments subglobular, the outer segments oval to elongate-oval. Head brownish gray.

Mesonotum with a broad median brown stripe, the lateral portions of the sclerite broadly and conspicuously golden-yellow pollinose; lateral præscutal stripes scarcely indicated; scutal lobes variegated with darker yellow; mediotergite black, sparsely pruinose, the lateral portions paling to yellow. Pleura yellow, the mesopleura and pleurotergite heavily pruinose. Halteres with basal portion of stem yellow, the outer portion and knob dark brown. Legs with the coxæ and trochanters yellow; fore femora black, the basal third yellow; remaining femora yellow, the tips more narrowly blackened, not including more than the distal fourth or fifth; tibiæ and tarsi dark brown to brownish black. Wings (Plate 1, fig. 11) with a strong yellow tinge, the costal border and outer radial field more-saturated brownish yellow; stigma and narrow seams along cord and outer end of cell 1st M_2 dark brown; a brownish seam along vein Cu in cell M; veins brownish yellow, darker in the clouded areas. Venation: Sc_1 ending a short distance beyond origin of Rs, Sc_2 some distance before this origin; free tip of Sc_2 and R_2 in transverse alignment; m-cu close to fork of M, subequal to or a little longer than distal section of Cu_1; anal veins at origin subparallel or very slightly convergent.

Abdomen with the basal six segments orange-yellow, the remaining segments black. Ovipositor with the cerci relatively short and unusually slender, gently upcurved to the acute tips, a little longer than the hypovalvæ.

Habitat.—Kashmir.

Holotype, female, Kaj-Nag Range, altitude 9,000 feet, May 30, 1934 (*Miss Hutchinson*).

Limonia (*Dicranomyia*) *transfuga* is quite distinct from other regional members of the subgenus, superficially bearing a certain resemblance to *L.* (*D.*) *baileyi* (Edwards), of Tibet, yet entirely distinct.

PEDICIINI

DICRANOTA (RHAPHIDOLABIS) SUBSORDIDA sp. nov. Plate 1, fig. 12; Plate 3, fig. 37.

General coloration gray, the præscutum with a darker median stripe; antennæ black throughout; knobs of halteres infuscated; legs brownish black; wings grayish subhyaline, the oval stigma brown; R_{2+3+4} approximately twice the basal section of R_5; abdominal tergites dark brown, hypopygium brownish yellow;

male hypopygium with the caudal margin of tergite transverse, each outer angle produced into a low setiferous lobe; interbase widely expanded on proximal portion.

Male.—Length, about 5 millimeters; wing, 6.2.

Rostrum gray; palpi black. Antennæ short, black throughout, the scape a little pruinose. Head gray.

Mesonotum gray, the præscutum with a darker, plumbeous gray, median stripe. Pleura gray. Halteres pale, the knobs infuscated. Legs with the coxæ pruinose on outer face, the inner face pale; trochanters yellow; femora brownish black, the bases restrictedly pale; tibiæ and tarsi brownish black. Wings (Plate 1, fig. 12) grayish subhyaline; stigma oval, brown; veins dark brown. Venation: R_{2+3+4} approximately twice the basal section of R_5; R_2 transverse; cell M_1 unusually small, the inclosing branches divergent; m-cu about one-half its length beyond fork of M.

Abdominal tergites dark brown; sternites somewhat paler, slightly pruinose; hypopygium brownish yellow. Male hypopygium (Plate 3, fig. 37) with the tergite, 9*t*, transverse across caudal margin, each lateral portion produced into a low, rounded, setiferous lobe. Dististyle, *d*, with the outer blade elongate, flattened, a little expanded on outer end and here provided with several setæ. Interbase, *i*, a yellow blade, very widely expanded on proximal portion, gradually narrowed outwardly, the tip narrowly obtuse.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 8,000 feet, May 18, 1934 (*Miss Hutchinson*).

The species is most readily told from *Dicranota* (*Rhaphidolabis*) *sordida* (Brunetti) by the black antennæ and almost uniformly darkened legs.

DICRANOTA (RHAPHIDOLABIS) UNINEBULOSA sp. nov. Plate 1, fig. 13; Plate 3, fig. 38.

General coloration gray, the præscutum without evident stripes; antennal flagellum black; knobs of halteres weakly darkened; femora brownish yellow, the tips weakly darkened; wings subhyaline, stigma brown; a small brown cloud on anterior cord; R_{2+3+4} fully one-half longer than basal section of vein R_5; abdomen brown, sparsely pruinose, the extreme caudal margins of the segments pale; hypopygium yellow; male hypopygium with the interbase curved, the apex flattened and having the margin microscopically serrulate.

Male.—Length, about 6.5 millimeters; wing, 7.5.

Rostrum gray; palpi dark. Antennæ short; scape and pedicel brownish black, flagellum black; antennæ 15-segmented; flagellar segments short-oval to subglobular. Head dark gray.

Mesonotum gray, the præscutum without evident stripes. Pleura gray. Halteres pale, the knobs weakly darkened. Legs with the coxæ pale, gray pruinose; femora brownish yellow, the tips weakly darkened; tibiæ pale brown, the tips, together with the tarsi, more brownish black. Wings (Plate 1, fig. 13) subhyaline; stigma brown; a small but distinct brown cloud on anterior cord; veins brown. Venation: R_{2+3+4} fully one-half longer than the basal section of vein R_5; R_2 transverse or nearly so; M almost in direct alignment with M_{1+2}, the basal section of the latter lacking or virtually so; m-cu about one-half its length beyond fork of M.

Abdomen brown, sparsely pruinose; extreme caudal margins of segments pale; hypopygium yellow. Male hypopygium with the interbase (Plate 3, fig. 38, *i*) curved, the apex flattened, its margin microscopically serrulate.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 8,000 feet, May 26, 1934 (*Miss Hutchinson*).

Dicranota (*Rhaphidolabis*) *uninebulosa* is readily told from the other Himalayan species of the subgenus by the large size and the pattern of the wings.

DICRANOTA (RHAPHIDOLABIS) PALLIDITHORAX sp. nov. Plate 1, fig. 14; Plate 3, fig. 39.

General coloration of thorax pale brownish yellow; antennæ dark brown, the scape brownish yellow; knobs of halteres darkened; wings subhyaline, the stigmal area faintly darker; R_{2+3+4} about one-half longer than the basal section of vein R_5; R_2 oblique; male hypopygium with the interbase on mesal face at near midlength produced into a spinous point.

Male.—Length, about 7 millimeters; wing, 7.8.

Female.—Length, about 8 millimeters; wing, 8.5.

Rostrum brown, paler laterally; palpi brown. Antennæ short, 15-segmented; scape brownish yellow, remaining segments dark brown. Head light gray throughout.

Pronotum and mesonotum, together with the pleura, entirely pale brownish yellow to yellow, without markings. Halteres pale, the knobs darkened. Legs with the coxæ and trochanters yellow; femora brownish yellow, clearer yellow basally, darker outwardly; tibiæ and tarsi dark brown. Wings (Plate 1, fig.

14) subhyaline, iridescent; stigmal area faintly darker, pale brown; veins brown. Venation: Rs of moderate length; R_{2+3+4} about one-half longer than the basal section of vein R_5; R_2 oblique, exceeding one-half R_{1+2}; m-cu about its own length beyond the fork of M.

Abdominal tergites dark brown, the caudal borders of the segments very narrowly pale; basal sternites obscure yellow, the outer segments somewhat more darkened; hypopygium chiefly yellow. Male hypopygium with the interbase (Plate 3, fig. 39, *i*) of characteristic shape, on mesal face at near midlength produced into an acute spinous point, the apical portion slender, narrowed before the oval distal end.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 8,000 feet, May 22, 1934 (*Miss Hutchinson*). Allotopotype, female.

Dicranota (*Rhaphidolabis*) *pallidithorax* is very distinct from the other Asiatic species of the subgenus so far described in the major size, the pale coloration of the thorax, and the structure of the interbase of the male hypopygium.

DICRANOTA (AMALOPINA) FUMICOSTATA sp. nov. Plate 1, fig. 15; Plate 3, fig. 40.

Mesonotal præscutum yellow, with a median darker stripe; posterior sclerites of mesonotum darkened; legs yellow; wings yellow, the costal border to apex broadly infumed, including all of cells C and Sc; smaller darker areas on certain of the veins and crossveins; no supernumerary crossvein in cell R_1; R_{2+3+4} short; cell 1st M_2 closed; male hypopygium with both the tergal arms and the interbases appearing as stout flattened blades that terminate in acute spines.

Male.—Length, about 5.5 millimeters; wing, 6.5.

Rostrum and palpi brownish black. Antennæ with the scape brownish black; pedicel brownish yellow; flagellum light yellow, only the outer two or three segments more darkened. Head brown; eyes relatively large and protuberant.

Cervical sclerites and central portion of pronotum dark brown. Mesonotal præscutum yellow, with a more brownish median stripe; lateral stripes narrow and scarcely evident; posterior sclerites of mesonotum darker brown, this color including the posterior border of the pleurotergite. Remainder of pleurotergite and all of the pleura pale yellow. Halteres with the stem yellow, its outer end and the knob infuscated. Legs with the coxæ and trochanters pale yellow; remainder of legs light yellow,

only the last tarsal segment darkened. Wings (Plate 1, fig. 15) with the ground color yellowish, the costal border to apex broadly infumed, the darkening including all of cells C and Sc, together with the basal third of cell R; restricted darker brown areas at origin of Rs, along cord, R_2, outer end of cell 1st M_2 and fork of M_{1+2}; veins pale, darker in the infumed areas. Venation: Sc_2 lying at near three-fifths the distance between arculus and origin of Rs; no supernumerary crossvein in cell R_1; cell R_3 short-petiolate, R_{2+3+4} being represented by an element that is subequal to or shorter than the basal section of R_5; cell 1st M_2 closed; m-cu about one-half its length beyond the fork of M.

Abdominal tergites brown, the sternites paler; abdomen darker apically. Male hypopygium (Plate 3, fig. 40) with the lateral arms of the tergite, *9t*, appearing as powerful erect rods, the tip incurved to a short acute spine; median area of tergite slightly convex, with abundant setæ. Interbases, *i*, large and powerful, appearing as sinuous yellow blades, the tip of each narrowed into an acute spine. Dististyle unusually simple, the outer lobe with the usual close-set spines, the inner blade with numerous setæ.

Habitat.—Formosa (north).

Holotype, male, Urai, altitude 1,500 feet, April 1, 1932 (*Gressitt*).

Dicranota (*Amalopina*) *fumicostata* is very different from the other regional species of the subgenus, the distinctions being best shown by the accompanying key to the five species now known from the Japanese Empire.

Key to the Japanese species of Amalopina.

1. Cell 1st M_2 open by atrophy of m; fore and middle femora brownish black, the posterior femora and remainder of all legs light yellow (*gibbera* and races) .... 2.
   Cell 1st M_2 closed; legs yellow .... 3.
2. Wings (male) broad, widest opposite end of vein 2d A. (Japan.) *gibbera gibbera* Alexander.
   Wings (male) narrow, of approximately equal width along the central third of length. (Japan.) .... *gibbera karafutonis* Alexander.
3. No supernumerary crossvein in cell R_1; outer ends of radial cells uniformly infumed. (Formosa.) .... *fumicostata* sp. nov.
   A supernumerary crossvein in cell R_1; outer ends of radial cells clear or with darkenings at ends of veins only .... 4.
4. Cells C and Sc undarkened. (Japan.) .... *dicranotoides* Alexander.
   Cell C, and usually Sc also, strongly darkened on basal half .... 5.

5. Outer ends of all longitudinal veins with brown spots and dots. (Siberia and Korea.) .... *siberica* Alexander.
   Outer ends of longitudinal veins undarkened. (Formosa.)
   delectata Alexander.

It may be noted that all of the above species (excepting *siberica,* a male of which is not available to me at this time) show marked distinctions in the structure of the male hypopygium.

ERIOPTERINI

GONOMYIA (GONOMYIA) JUSTA sp. nov. Plate 1, fig. 16; Plate 3, fig. 41.

Belongs to the *tenella* (*subcinerea*) group; allied to *G.* (*G.*) *nebulicola;* antennæ black throughout; mesonotum grayish brown, restrictedly variegated with yellow; pleura sulphur yellow, variegated by reddish brown; legs dark brown; R_{2+3+4} strongly arcuated; male hypopygium with the outer lobe of basistyle relatively short, only a little longer than the dististyle, the latter broadly flattened, bispinous; blackened appendage of phallosome not spinous.

Male.—Length, about 4.2 millimeters; wing, 5.

Rostrum yellow; palpi brownish black. Antennæ black throughout; outer flagellar segments very slender, almost setaceous, the basal ones more enlarged. Head gray.

Pronotum and anterior pretergites light yellow. Mesonotum uniformly dark grayish brown, the humeral region and sides of præscutum restrictedly yellow; median area of scutum obscure yellow; posterior lateral portions of scutal lobes and the broad posterior border of scutellum dark yellow. Pleura light sulphur yellow, variegated by reddish or reddish brown on anepisternum and more extensively on ventral sternopleurite and meron. Halteres dusky, the base of stem light yellow. Legs with the coxæ reddish or yellow, the fore pair darker; trochanters obscure yellow; remainder of legs dark brown. Wings (Plate 1, fig. 16) uniformly tinged with gray, the stigma pale brown; veins dark brown. Venation: Sc_1 ending shortly beyond origin of Rs, Sc_2 opposite this origin; R_{2+3+4} strongly arcuated; basal section of R_5 reduced; cell 1st M_2 relatively small; m-cu at fork of M.

Abdominal tergites dark brown, the sternites and hypopygium more brownish yellow. Male hypopygium (Plate 3, fig. 41) with the outer lobe of basistyle, *b,* relatively short, only a little longer than the dististyle. Dististyle, *d,* broadly flattened, bearing two unequal spines on outer margin, the outermost long and

gently curved, with a single seta at base; second spine in axil of the first; no carina connecting the inner spine with apex of style, as is the case in *nebulicola*. Phallosome, *p*, with a single blackened appendage, this subobtuse at apex, not spinous.

Habitat.—Java.

Holotype, male, Mount Malabar, altitude about 4,000 feet, May 26, 1929 (*Mackerras*). Paratopotype, male.

Type in the National Collection, Federal Capital Territory, Canberra.

The nearest described ally of the present fly is undoubtedly *Gonomyia* (*Gonomyia*) *nebulicola* Alexander (Mindanao), which differs chiefly in the structure of the dististyle and phallosome of the male hypopygium, as contrasted above.

GONOMYIA (LIPOPHLEPS) TORAJA sp. nov. Plate 1, fig. 17; Plate 3, fig. 42.

Mesonotum dark gray, the scutellum obscure yellow, pruinose; thoracic pleura with a silvery white longitudinal stripe; knobs of halteres yellow; femora obscure yellow, the tips broadly blackened; wings with a grayish tinge, the ground color vaguely brightened by paler areas; veins along cord darkened; basal section of R_5 long; abdomen dark brown; male hypopygium with two dististyles, the outer a long simple black rod; inner style profoundly bifid, its outer arm fusiform, clothed with long conspicuous setæ.

Male.—Length, about 3 millimeters; wing, 3.2.

Rostrum and palpi black. Antennæ black; flagellar segments (male) with very long verticils. Head brownish yellow, the center of vertex darker.

Sides of pronotum and the anterior lateral pretergites whitish, the posterior pretergites more silvery. Mesonotal præscutum dark gray; pseudosutural foveæ black; scutum dark gray, including the median area; scutellum obscure yellow, sparsely pruinose, the base darkened; mediotergite dark, heavily pruinose. Pleura dark, including the dorsopleural membrane; a conspicuous silvery longitudinal stripe extending from behind the fore coxæ to the base of abdomen; indications of a second, much less distinct, obscure yellow stripe above the first, involving the pteropleurite, pleurotergite, and cephalic-lateral portions of the mediotergite. Halteres dusky, the knobs yellow apically. Legs with the coxæ dark brown, the fore coxæ pale on outer face; trochanters brownish yellow; femora obscure yellow, the tips broadly black (certain of the femoral tips are broken and it cannot be affirmed as to whether or not certain of these areas

are slightly subterminal); tibiæ yellow, the tips very narrowly darkened; tarsi broken. Wings (Plate 1, fig. 17) with a grayish tinge, the ground color vaguely brightened by paler areas, chiefly before origin of Rs and beyond stigma; stigmal area very faint; a darkened area along cord, indicated chiefly by the darker veins; veins pale, except as described. Costal fringe long. Venation: Sc_1 ending shortly before the origin of Rs; basal section of R_5 long; m-cu shortly before fork of M.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 3, fig. 42) with the basistyle, *b*, unproduced at outer end. Two dististyles, the outer, *od*, a long, simple, blackened rod, curved and gently sinuous to the acute tip; inner style, *id*, profoundly bifid, its outer arm a yellow fusiform structure that terminates in an acute spine, the surface with abundant setæ; inner arm shorter, with marginal setæ. Phallosome, *p*, consisting of two pairs of broadly flattened, superimposed plates.

Habitat.—Central Celebes (District Bontoe Batoe).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 15, 1931 (*Clagg*).

Gonomyia (*Lipophleps*) *toraja* is named from an aboriginal tribe inhabiting central Celebes. The species is readily told from all other regional species of the subgenus by the structure of the male hypopygium. This latter has a structure generally like that of *G.* (*L.*) *kerteszíana* Alexander (northeastern New Guinea), but the details are entirely different.

GONOMYIA (LIPOPHLEPS) TOALA sp. nov. Plate 1, fig. 18; Plate 3, fig. 43.

General coloration of notum dark brownish gray, the lateral border of the præscutum conspicuously lighter gray; pleura striped longitudinally with whitish; halteres yellow; femora and tibiæ brownish yellow; wings yellowish gray; stigmal area faintly indicated; Rs angulated, and, in cases, short-spurred at origin; male hypopygium with three dististyles, the intermediate one profoundly bifid; phallosome consisting of flattened pale plates, without blackened points or spines.

Male.—Length, about 2.8 to 3 millimeters; wing, 3.4 to 3.6.

Rostrum and palpi black. Antennæ black, the pedicel more or less brightened; verticils (male) unusually long and delicate. Head brownish gray, more or less variegated by paler gray.

Mesonotum chiefly dark brownish gray, the lateral border of the præscutum conspicuously lighter gray; posterior sclerites of notum, including the scutellum, gray. Pleura brown, with a broad whitish longitudinal stripe extending from and including

the fore coxæ to the base of abdomen, this stripe narrowly bordered both above and beneath by still darker brown. Halteres yellow. Legs with the coxæ brown, the fore coxæ whitish, as described; trochanters obscure yellow; remainder of legs brownish yellow, the outer tarsal segments more blackened. Wings (Plate 1, fig. 18) with a yellowish gray tinge, the prearcular and costal portions a little clearer yellow; stigmal area faintly indicated; veins pale. Venation: Sc of moderate length, Sc_1 ending a short distance before origin of Rs; Rs angulated and sometimes short-spurred at origin; m-cu a short distance before fork of M.

Abdomen dark brown, the pleural region paler; incisures, especially of the outer segments, a little brightened. Male hypopygium (Plate 3, fig. 43) with the apex of basistyle, *b*, unproduced. Three dististyles; outer, *od*, a slender, nearly straight rod, the apex narrowly blackened and gently curved into a spine, the outer margin with a series of microscopic setæ; intermediate style, *md*, profoundly bifid, the outer arm a little longer than the outer style, appearing as a flattened pale blade that is slightly arcuate; inner arm of this style much shorter, its apex a blackened spine; inner style, *id*, elongate-oval, with numerous setæ, none of which is evidently fasciculate. Phallosome, *p*, appearing as two flattened pale plates, with a slenderer median pale structure, the entire organ without blackened points or spines.

Habitat.—Central Celebes (District Bontoe Batoe).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 15, 1931 (*Clagg*). Paratopotype, male.

The specific name of this species, *toala*, is that of an aboriginal tribe. The fly is quite distinct from all other regional members of the subgenus in the structure of the male hypopygium, especially the profoundly bifid intermediate dististyle and the entirely pale phallosome.

LIPSOTHRIX KASHMIRICA sp. nov. Plate 1, fig. 19; Plate 3, fig. 44.

Thorax yellow; legs yellow, the tips of femora and narrow bases of tibiæ brownish black; wings whitish hyaline, without stigma; veins brown, the prearcular veins light yellow; abdominal tergites with a broad, continuous, dark brown, median stripe; male hypopygium with the interbase bearing two small acute spines on outer face before midlength.

Male.—Length, 7.5 to 8 millimeters; wing, 8 to 8.5.

Female.—Length, 8.5 to 9.5 millimeters; wing, 9 to 9.5.

Rostrum yellow, palpi pale. Antennæ with basal segments pale yellow, the outer ones passing into brown; the number of pale basal segments varies considerably in different specimens, in some cases involving several of the flagellar segments, as well as the scape and pedicel. Head brownish yellow.

Thorax entirely yellow. Halteres yellow. Legs yellow, the femoral tips and narrower tibial bases brownish black; tips of tibiæ narrowly darkened; outer tarsal segments infuscated. Wings (Plate 1, fig. 19) whitish hyaline, without stigmal or other markings; veins brown, the prearcular veins light yellow. Macrotrichia on all longitudinal veins beyond cord, including the outer ends of both anal veins, the amount on the latter veins variable in different specimens. Venation: m-cu at or close to fork of M; basal section of R_5 and r-m often angulated and weakly spurred.

Abdominal tergites with a broad, continuous, dark brown, median stripe, the lateral borders of the segments yellow, more widely so on the outer segments; seventh to ninth segments (male) uniformly blackened. Male hypopygium (Plate 3, fig. 44) with the interbase, *i*, long and sinuous, at base with a slender spinous point; on outer margin before midlength with two small acute spines.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 9,000 feet, May 30, 1934 (*Miss Hutchinson*). Allotopotype, female, altitude 8,000 feet, May 24, 1934. Paratopotypes, 15 of both sexes, altitude 8,000 feet, May 22 to 30, 1934.

Lipsothrix kashmirica is most nearly allied to *L. errans* (Walker), differing especially in the nearly hyaline wings and conspicuous, entire, median dark stripe on abdominal tergites. Edwards[2] has indicated the existence in Europe of no fewer than four species, of which three occur in Britain. Four other species are found in Japan and Formosa, but hitherto none had been recorded from the Asiatic mainland.

ORMOSIA HUTCHINSONÆ sp. nov. Plate 1, fig. 20; Plate 3, fig. 45.

Mesonotum gray, with scarcely indicated præscutal stripes; antennæ with scape and pedicel pale, flagellum black; thoracic pleura yellow; knobs of halteres dark brown, femora yellow, the tips broadly blackened; wings whitish subhyaline; stigma and

[2] Entomologist 63 (1930) 212.

very narrow seams along cord and outer end of cell 1st M_2 brown; cell 1st M_2 closed; anal veins divergent; abdominal tergites brownish black, the sternites and hypopygium yellow.

Male.—Length, 3.8 to 4.2 millimeters; wing, 4.5 to 5.

Female.—Length, about 5 to 5.5 millimeters; wing, 5.5 to 6.

Rostrum brownish yellow to yellow; palpi dark brown. Antennæ short; scape light yellow; pedicel brownish yellow; flagellum black; flagellar segments oval, the outer segments a little more elongate. Front light yellow; vertex light gray.

Mesonotum gray, the præscutal stripes not or scarcely defined; tuberculate pits black, conspicuous; lateral margins of præscutum paling to yellow; lateral pretergites light yellow. Pleura yellow to weakly infumed, contrasting with the notum. Halteres dark brown, the basal portion of stem yellow. Legs with the coxæ and trochanters light yellow; femora yellow, the tips broadly blackened; tibiæ brown, the tips blackened; tarsi black. Wings (Plate 1, fig. 20) whitish subhyaline; stigma and very narrow seams along cord and outer end of cell 1st M_2 brown; veins brown. Venation: Cell 1st M_2 closed; m-cu not far beyond the fork of M; anal veins divergent.

Abdominal tergites brownish black, sparsely pruinose; lateral borders of segments very narrowly pale; sternites and hypopygium light yellow. Male hypopygium (Plate 3, fig. 45) with the dististyle, *d*, apparently simple but deeply bifid, the outer arm a cylindrical blackened structure that terminates in a group of acute teeth; inner arm pale, broad-based, narrowed to a long slender point, the tip obtuse.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 8,000 feet, May 15, 1934 (*Miss Hutchinson*). Allotopotype, female. Paratopotypes, 15 of both sexes.

Ormosia hutchinsonæ is named in honor of Miss Vivien R. Hutchinson, to whom I am greatly indebted for many interesting Tipulidæ from Kashmir. The species is readily distinguished from all other Palæarctic species having cell 1st M_2 closed by the coloration of the body and peculiar conformation of the dististyle of the male hypopygium.

STYRINGOMYIA CELEBESENSIS sp. nov. Plate 1, fig. 21; Plate 3, fig. 46.

General coloration yellow; mesonotum, especially the scutum, with specially modified setæ; wings with vein R_3 nearly transverse; 2d A strongly curved to margin; male hypopygium with

apex of basistyle bispinous; outer arm of dististyle without median projection.

Male.—Length, about 5.3 to 5.5 millimeters; wing, 5.2 to 5.4.

Female.—Length, about 5 millimeters; wing, 4.5.

Rostrum brown; palpi dark brown, the terminal segment paler. Antennæ with the scape and pedicel dark beneath, more yellow above; flagellum yellow, the basal segments short and crowded. Head grayish brown; setæ large and conspicuous.

Pronotum whitish, with conspicuous setæ. Mesonotal præscutum yellowish brown, vaguely lined with darker brown; notal setæ conspicuous, especially those of the scutum, much as in *S. ensifera;* mediotergite pale. Pleura testaceous-yellow. Halteres yellow. Legs with the coxæ and trochanters yellow; remainder of legs yellow, the femoral and tibial rings broad but diffuse, brown; fore femora with a group of strong black setæ at tip; tarsi pale, the tips of the segments narrowly darkened. Wings (Plate 1, fig. 21) pale yellow, the costal border slightly more saturated; small dark areas on r-m; both ends of basal section of vein M_3 but with the intermediate portion pale, m-cu; marginal spots at ends of all medial, cubital, and anal veins, largest and most conspicuous on 2d A. Venation: R_3 nearly transverse; cell 2d M_2 narrow to broadly sessile; vein 2d A strongly curved into margin but without angulation.

Abdomen obscure yellow, the caudal borders of the tergites narrowly darkened. Male hypopygium (Plate 3, fig. 46) with two broadly flattened spines on basistyle, *b*, these sessile or from very short lobes. Outer lobe of dististyle, *od*, with the basal portion pale and slightly dilated, with abundant setæ; more than the outer half of arm narrowed and darkened; no lobe at near midlength, as in *ensifera;* intermediate, *md*, and inner, *id*, arms of dististyle complex, especially the latter. Tenth tergite, *t*, with an elongate liguliform terminal lobe. Ninth sternite, 9*s*, broad, the usual modified outer setæ distinctly subterminal in position, the sternite projecting strongly beyond their insertion, narrowed and feebly darkened at apex.

Habitat.—Central Celebes (District Bontoe Batoe).

Holotype, male, Latimodjong Mountains, altitude, 3,800 feet, May 15, 1931 (*Clagg*). Allotopotype, female. Paratopotypes, 1 male, 2 females.

The other species of *Styringomyia* with bispinous basistyles (*armata* Edwards, *claggi* Alexander, *ensifera* Edwards) differ

conspicuously from the present fly in the structure of the male hypopygium. The latter comes closest to *ensifera,* differing in the conformation of both inner lobes of the dististyle and the lack of a medium lobule on the outer arm of the style.

STYRINGOMYIA SIBERIENSIS sp. nov. Plate 1, fig. 22; Plate 3, fig. 47.

General coloration of mesonotum pale, variegated with darker; scutellum black, with a yellow central spot; wings with brown clouds on r-m, m-cu, outer end of cell 1st M_2, and end of vein 2d A; vein 2d A angulated and more or less spurred near outer end; male hypopygium with the basistyle bearing a single lobe and spine; ninth sternite with two setæ.

Male.—Length, about 5.5 millimeters; wing, 4.2.

Female.—Length, about 5.3 millimeters; wing, 4.3.

Rostrum and palpi brownish black. Antennæ with scape and pedicel black; flagellum obscure yellow throughout. Head brownish yellow, sparsely pruinose; occipital region with a brown area on either side of the median line.

Pronotum pale medially, dark brown on sides. Mesonotal præscutum brownish gray, narrowly lined with darker brown; scutal lobes brown, the centers brownish yellow; median area of scutum yellow; scutellum black with a yellow median spot; mediotergite brownish black, sparsely pruinose; pleurotergite testaceous-yellow. Pleura variegated dark brown and obscure yellow. Halteres pale yellow throughout. Legs with the coxæ and trochanters yellow; remainder of legs yellow, the femora with two narrow dark brown rings that are interrupted beneath; tibiæ yellow, with two brown rings, the median one incomplete; tarsi yellow, the terminal segment abruptly darkened. Wings (Plate 1, fig. 22) yellow, with brown clouds on r-m, m-cu, outer end of cell 1st M_2, and end of vein 2d A; veins yellow, darkened in the clouded areas. Venation: Cell 2d M_2 narrow to more broadly sessile; vein 2d A angulated and short- to long-spurred at point of angulation.

Abdominal tergites more or less bicolorous, especially in male; obscure yellow in central portions, the bases and more narrow tips brown; sternites uniformly pale yellow. Male hypopygium (Plate 3, fig. 47) with the tenth tergite, *t,* produced into a conspicuous apical lobe; ninth sternite, *9s,* slender, the two setæ close together. Basistyle, *b,* with the outer lobe slender, exceeding its terminal spine in length. Dististyle with the outer arm, *od,* provided with a series of four setæ at near midlength; inner arm, *id,* with the marginal spines in three groups; from near the

second of these groups arises a slender pale lobe that is tipped with a spine; discal setæ of inner arm about fourteen in number; intermediate arm, *md*, with apex produced into a single, powerful, black spine, with a comb of smaller black pegs just beneath it; a further comb of pegs some distance basad of the first group.

Habitat.—Eastern Siberia (Ussuri).

Holotype, male, Vinogradovka, 133° 50′ east longitude, 43° 20′ north latitude, August 10, 1929 (*Kiritchenko*). Allotopotype, female.

The types are preserved in the museum of the Russian Academy of Sciences.

As is usual in this involved genus, the present species is best defined by the structure of the dististyle of the male hypopygium, especially the armature of the intermediate and inner lobes. By Edwards's key to the species of *Styringomyia* [3] the present fly runs to *crassicosta* (Speiser), an African species. *Styringomyia siberiensis* is allied to two other species described at this time (*omeiensis* sp. nov. and *separata* sp. nov.), but differs from both in hypopygial characters. I had earlier [4] indicated the occurrence of this tropicopolitan genus in Siberia, this note being based upon the present record. The species is more northern in its distribution than any other so far made known, the most northerly previous record being for *S. nipponensis* Alexander, from Honshiu Island, Japan, latitude about 35° north.

STYRINGOMYIA OMEIENSIS sp. nov. Plate 1, fig. 23; Plate 3, fig. 48.

General coloration chiefly pale, the abdomen only slightly patterned; wings with the usual four dark spots; cell 2d M_2 broadly sessile; vein 2d A angulated and spurred at outer end; male hypopygium with the setæ of the ninth sternite slightly separated; dististyle with inner arm terminating in a single very long spine, with a group of about three smaller spines at its base.

Male.—Length, about 5 millimeters; wing, 4.8.

Rostrum brownish yellow; palpi light brown. Antennæ with the scape blackened beneath, obscure yellow above; pedicel brownish black; flagellum broken. Head chiefly pale.

Mesonotal præscutum pale, lined with brownish black on anterior portion; scutum chiefly pale; scutellum blackish, pale medially; mediotergite darkened. Pleura pale yellow. Halteres broken. Legs with the fore and middle coxæ pale yellow; femora

[3] Trans. Ent. Soc. London for 1914 (1914) 210–212.

[4] Philip. Journ. Sci. 52 (1933) 395.

pale yellow, each with two narrow dark rings that are slightly interrupted beneath; tibiæ with the apex and a premedial ring dark; tarsal segments whitish, the fore tarsi with the tips of the individual segments narrowly darkened; terminal segment black. Wings (Plate 1, fig. 23) pale yellow, with the usual four dark spots at r-m, m-cu, outer end of cell 1st M_2, and outer end of vein 2d A. Venation: Cell 2d M_2 broadly sessile, vein 2d A angulated and spurred at outer end.

Abdomen chiefly pale yellow, only slightly patterned at posterior borders of the tergites. Male hypopygium (Plate 3, fig. 48) with the ninth sternite, *9s*, relatively broad at tip, the two setæ slightly separated at base. Armature of dististyle as shown; note that the apex of inner arm, *id*, terminates in one very long spine, surrounded at base by about three shorter ones; from this apical group the margin of the lobe slopes obliquely to base, with an almost continuous group of peglike spines along this margin; discal spines about a dozen in number.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 9, 1929 (*Franck*).

Styringomyia omeiensis is most nearly allied to *S. separata* sp. nov. and *S. siberiensis* sp. nov., being most readily distinguished by the details of structure of the male hypopygium. As in the case of the species mentioned, by the use of Edwards's key to the species of the genus,[5] the present fly runs to *S. crassicosta* (Speiser), of Africa.

STYRINGOMYIA SEPARATA sp. nov. Plate 1, fig. 24; Plate 3, fig. 49.

Male.—Length, about 6 millimeters; wing, 4.5.

Female.—Length, about 5 millimeters; wing, 4.

Characters much as in *S. omeiensis* sp. nov., to which it is most nearly allied, differing especially in the structure of the male hypopygium.

Præscutum almost entirely brownish yellow, the dark markings best represented by four areas immediately before the suture and by the strongly darkened cephalic portion of the sclerite before the pseudosutural foveæ, the two regions interconnected by narrow darkenings on the interspaces. Wings (Plate 1, fig. 24) with vein 2d A very weakly angulated but unspurred. Male hypopygium (Plate 3, fig. 49) with the inner lobe, *id*, of

[5] Trans. Ent. Soc. London for 1914 (1914) 210–212.

the dististyle of distinctive conformation, the outer point terminating in about six powerful spines that are widely separated from the next group along the margin by a broad U-shaped notch; discal group of spines about ten in number, all long and slender; at base of inner lobe on mesal face with a small pale point.

Habitat.—Formosa (north).

Holotype, male, Rimozan, May 2, 1933 (*Issiki*).

Allotopotype, female, pinned with type.

ILLUSTRATIONS

[*a*, Ædeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *md*, intermediate lobe of dististyle; *od*, outer dististyle or outer lobe of dististyle; *p*, phallosome; *s*, sternite; *t*, tergite.]

PLATE 1

FIG. 1. *Trichocera arisanensis* sp. nov., venation.
2. *Longurio (Longurio) variceps* sp. nov., venation.
3. *Tipula (Acutipula) alboplagiata* sp. nov., venation.
4. *Tipula (Schummelia) indifferens* sp. nov., venation.
5. *Tipula (Schummelia) nigrocellula* sp. nov., venation.
6. *Tipula (Lunatipula) trialbosignata* sp. nov., venation.
7. *Tipula gressitti* sp. nov., venation.
8. *Nephrotoma atrolatera* sp. nov., venation.
9. *Dolichopeza (Nesopeza) lugubrivestis* sp. nov., venation.
10. *Limonia (Limonia) subhostilis* sp. nov., venation.
11. *Limonia (Dicranomyia) transfuga* sp. nov., venation.
12. *Dicranota (Rhaphidolabis) subsordida* sp. nov., venation.
13. *Dicranota (Rhaphidolabis) uninebulosa* sp. nov., venation.
14. *Dicranota (Rhaphidolabis) pallidithorax* sp. nov., venation.
15. *Dicranota (Amalopina) fumicostata* sp. nov., venation.
16. *Gonomyia (Gonomyia) justa* sp. nov., venation.
17. *Gonomyia (Lipophleps) toraja* sp. nov., venation.
18. *Gonomyia (Lipophleps) toala* sp. nov., venation.
19. *Lipsothrix kashmirica* sp. nov., venation.
20. *Ormosia hutchinsonæ* sp. nov., venation.
21. *Styringomyia celebesensis* sp. nov., venation.
22. *Styringomyia sibericnsis* sp. nov., venation.
23. *Styringomyia omeiensis* sp. nov., venation.
24. *Styringomyia separata* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula (Acutipula) alboplagiata* sp. nov., male hypopygium, details.
26. *Tipula (Acutipula) alboplagiata* sp. nov., male hypopygium, details.
27. *Tipula (Schummelia) indifferens* sp. nov., male hypopygium, details.
28. *Tipula (Schummelia) indifferens* sp. nov., male hypopygium, details.
29. *Tipula (Schummelia) nigrocellula* sp. nov., male hypopygium, ninth tergite.
30. *Tipula (Lunatipula) trialbosignata* sp. nov., male hypopygium, details.

FIG. 31. *Tipula (Lunatipula) trialbosignata* sp. nov., male hypopygium, ninth tergite.
32. *Tipula (Oreomyza) arisanensis* Edwards, male hypopygium, dorsal aspect.
33. *Tipula (Oreomyza) arisanensis* Edwards, male hypopygium, lateral aspect.
34. *Tipula gressitti* sp. nov., male hypopygium, details.
35. *Dolichopeza (Nesopeza) lugubrivestis* sp. nov., male hypopygium, details.

PLATE 3

FIG. 36. *Limonia (Limonia) subhostilis* sp. nov., male hypopygium.
37. *Dicranota (Rhaphidolabis) subsordida* sp. nov., male hypopygium.
38. *Dicranota (Rhaphidolabis) uninebulosa* sp. nov., male hypopygium, interbase.
39. *Dicranota (Rhaphidolabis) pallidithorax* sp. nov., male hypopygium, interbase.
40. *Dicranota (Amalopina) fumicostata* sp. nov., male hypopygium.
41. *Gonomyia (Gonomyia) justa* sp. nov., male hypopygium.
42. *Gonomyia (Lipophleps) toraja* sp. nov., male hypopygium.
43. *Gonomyia (Lipophleps) toala* sp. nov., male hypopygium.
44. *Lipsothrix kashmirica* sp. nov., male hypopygium.
45. *Ormosia hutchinsonæ* sp. nov., male hypopygium.
46. *Styringomyia celebesensis* sp. nov., male hypopygium.
47. *Styringomyia siberiensis* sp. nov., male hypopygium.
48. *Styringomyia omeiensis* sp. nov., male hypopygium.
49. *Styringomyia separata* sp. nov., male hypopygium.

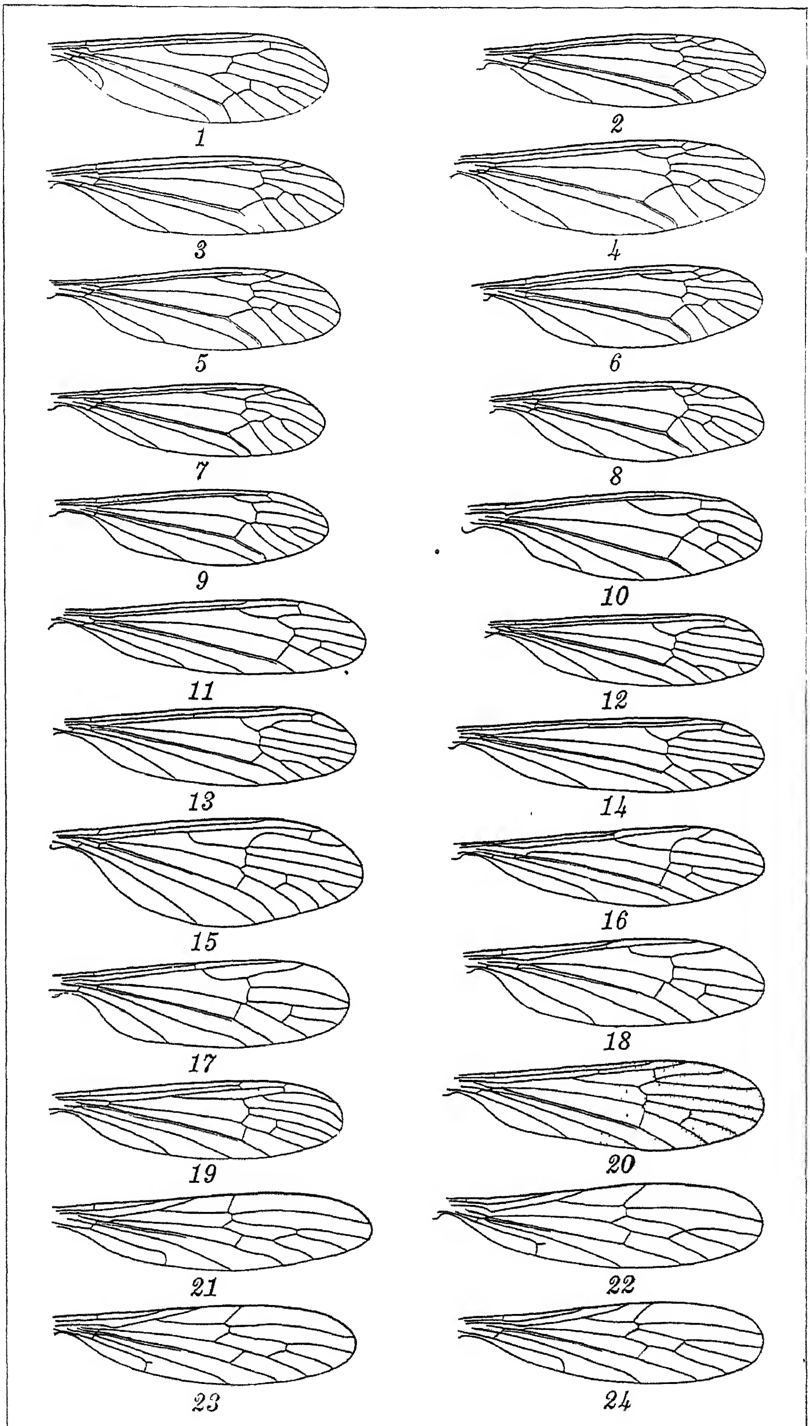

PLATE 1.

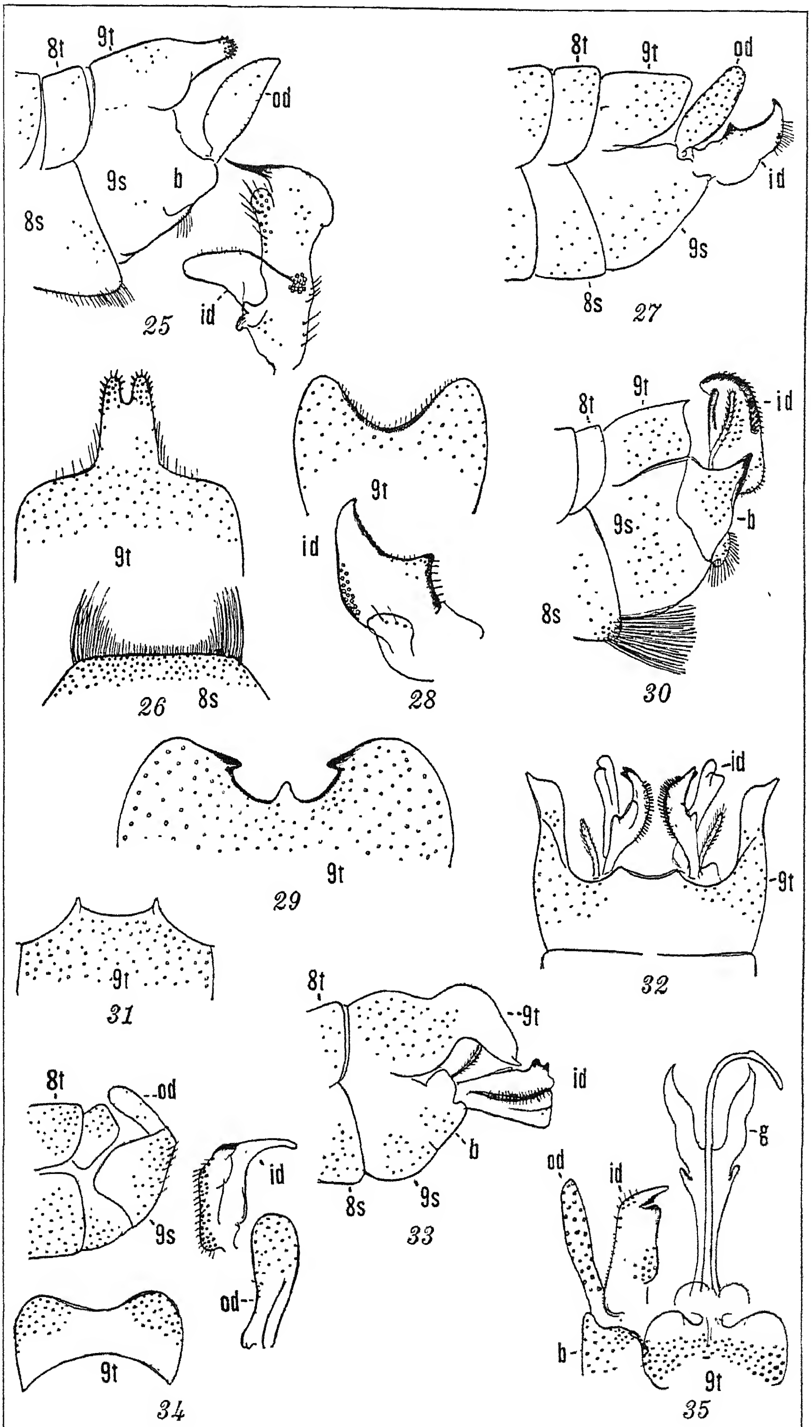
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PLATE 2.

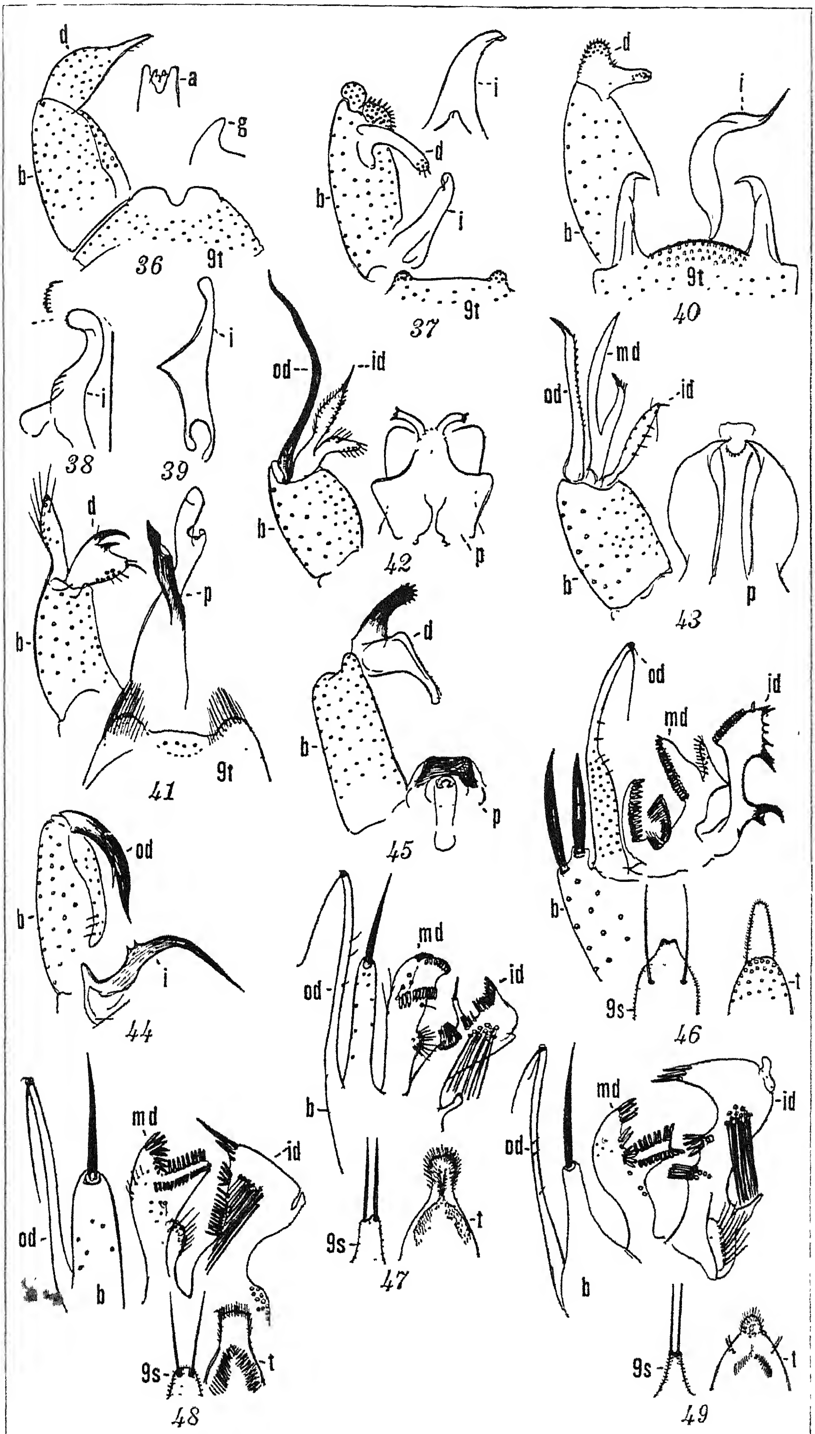
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PLATE 3.

SPERMATID TRANSFORMATION IN AMBLYCORYPHA OBLONGIFOLIA (DE GEER), A TETTIGONIID

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Of the Department of Zoölogy, University of Kansas, Lawrence

TWO PLATES

INTRODUCTION

This study gives a detailed account of the metamorphosis of the spermatids in *Amblycorypha oblongifolia* (De Geer), a tettigoniid, and follows the changes taking place during the process.

While cytologists have worked on the spermatocyte divisions of many species of Tettigoniidæ, only a few have published papers dealing with spermatid transformation. Sabatier (1890), Otte (1907), and Davis (1908) are among the few investigators who have worked on spermatid transformation. The accounts of Sabatier and Davis, however, are rather short and show an incomplete series of changes. The paper of Otte, as far as we know, is the only one that gives a detailed history.

MATERIAL AND METHODS

The species selected for this study is *Amblycorypha oblongifolia*. Its spermatogenesis has not been worked out before. All of the material was obtained from adult individuals, collected in the neighborhood of the University of Kansas during July and August, 1932.

Various fixing agents were tried, but Flemming's fluid and Benda's proved by far the best. The material was stained in sections 6 and 10 microns thick. Many staining combinations were tried, but Benda's method and Heidenhain's iron-hæmatoxylin with a counterstain gave the most satisfactory results.

Observations were made on both sectioned and live material, but mostly on the former. The "intravitam technic," developed by Baumgartner and Payne (1931), was used whenever observations on live cells in the follicles were made. Smear preparations were also used for mature spermatozoa.

OBSERVATIONS

THE TESTES

Amblycorypha oblongifolia, one of the "false katydids," has paired testes. Each testis lies in the dorsal side of the abdomen, extending from the third to the sixth abdominal segment. In the adult the testis looks like a yellowish, somewhat flattened, strawberry.

Each testis is composed of many short cylindrical follicles of varying length. The follicles, which lie nearly parallel to each other, are usually larger in the middle and somewhat tapering at either end, depending upon the age of the individual, and are inclosed in a thin connective tissue containing yellowish pigment. Every follicle is made up of many cysts, which vary in size. In follicles of young individuals sectioned longitudinally, the germ cells are generally arranged in successively older generations, the spermatogonia lying at the blind end of the follicle, followed by the spermatocytes, which in turn are oriented in such a way that their heads point toward the blind end of the follicle.

SPERMATID FORMATION

As a result of the two spermatocyte divisions, four spermatids are produced from each primary spermatocyte. Two of these spermatids differ from the other two only in the possession of a large nuclear element—the compact accessory chromosome—otherwise they are structurally the same. Plate 1, figs. 9 and 10, represents two young spermatids, one having the extra element and the other lacking it. Figure 14 shows a spermatid at a little later stage. It shows the fully formed nucleus and the nebenkern. Figure 16 shows the acroblast. The nucleus, nebenkern, and acroblast are three of the most common and characteristic structures of most orthopteran spermatids that have been studied. Before proceeding to describe in detail the changes undergone by these structures during the process of spermatid transformation, the history of their origin will be traced.

The nucleus.—The spermatid nucleus pictured in figs. 14 and 15 arises from the anaphase chromosome plates of the second maturation division (figs. 2 and 3). During the anaphases, there is nothing of particular interest in the behavior of the chromosomes of this tettigoniid. They are distributed in the usual manner, one-half migrating to one pole of the spindle and the other half to the other pole (fig. 1), where they aggregate

at a little later stage (fig. 2). At this time the outlines of the individual chromosomes are still distinctly visible, but as the chromosomes fuse into a compact mass, all trace of their outlines is lost to view, except that of the accessory chromosome, which maintains its identity. Figures 3 and 6 show two cells in which the accessory chromosome is protruding from each compact mass of chromosomes (autosomes) and extending into the cytoplasm. In the telophases this compact mass resulting from the fusion of the chromosomes begins to show signs of internal disintegration (fig. 8). When the two daughter cells separate, the process of disintegration of the chromosome mass is well under way, the vacuoles in each having greatly increased in number, and every vacuole having become larger and more distinct (fig. 9). From this stage the mass of chromatin rapidly breaks up into patches of varying size, which in turn disintegrate into smaller pieces and larger granules. This breaking up of the mass gradually increases the size of the nucleus, which gains in volume at the expense of its density, while at the same time the substance itself becomes less chromophilic (figs. 10 to 13). When the nucleus reaches its maximum size (fig. 14), the nuclear membrane appears and the spermatid nucleus is completed. A glance at figs. 9 and 14 shows the increase in size of the nucleus from the time of separation of the two daughter cells until the formation of the nuclear membrane. These illustrations also show the gradual loss of affinity for nuclear stain.

The accessory chromosome, whenever present, remains intact throughout the stages of the formation of the spermatid nucleus. Its behavior differs markedly from that of the autosomes, in that it has not undergone a process of disintegration. It retains its compact form, and its staining reaction is similar to that of autosomes in metaphase. Before the formation of the nuclear membrane, it is usually found lying close to the periphery of the chromosome mass (figs. 10 to 13). After the appearance of this membrane, it takes a position close against its inner surface. It usually assumes an oval or lenticular shape. Because of its large size and staining reaction, it is easily distinguished from the rest of the nuclear elements, and appears very conspicuous in young spermatids.

The nebenkern.—The second outstanding characteristic structure of the spermatid is the nebenkern. In the early anaphase of the second maturation division, the mitochondria are found in the cytoplasm in the form of short rods and large granules.

They are always closely crowded together midway between the poles, just under the cell wall (fig. 1). In the middle anaphase the granular mitochondria have increased in size and become short rods of varying length. At this stage they are all in the form of short rods (fig. 2). They are closer to the spindle plate due to the elongation of the cytoplasm. In the next stage (fig. 3) many of the rods, especially those lying nearest the cell wall, join end to end to form long threads. These threads at first show the outlines of the short rods from which they are formed. At this stage a cross section of the cytoplasm below the chromosome plate (fig. 4) reveals the unequal distribution of the mitochondria around the spindle. At a little later stage (figs. 5 and 6) many of the short rods, by the process already described, become long threads, which extend from pole to pole of the spindle. A polar view of the cytoplasm of a cell in the same stage, as indicated in fig. 6, shows almost uniform distribution of the mitochondria (fig. 7). It is at this time that the chromosome plates begin their telokinetic movements, and the spindle fibers begin to disappear. In late telophase (fig. 8) the number of the long mitochondrial threads has increased greatly, but the number of the short rods has decreased. The long threads apparently become homogeneous in structure, for they stain uniformly. When the two daughter cells finally separate, the long threads, which extend from pole to pole, are divided transversely into approximately equal parts. The short rods, which lie at the interzonal region, are also divided. The rest of the short rods have been previously assorted to the cytoplasm on the polar side of each nucleus. Hence, the separation of the two daughter cells also divides these meristically, with the result that approximately one-half of the entire mitochondrial substance is assorted to each of the resulting spermatids.

Later the mitochondria in each spermatid clump into a rather loose mass near the nucleus, which is always found to lie on that side of the spermatid where the cytoplasm is greatest and almost diametrically opposite the centriole (fig. 9). This mass rapidly shortens and condenses, first assuming a more or less rectangular form, which stains darker at both ends (fig. 10). At this stage its threadlike structure is still distinct, but disappears as it rounds out into a ball-shaped body (fig. 14). This spherical body, which stains homogeneously with basic stains, is the so-called nebenkern.

The acroblast.—The third spermatid structure is the acroblast, which differentiates first as a small vesicle from the fused mass

of dictyosomes lying against the nuclear membrane. During the anaphases of the second spermatocyte division, the dictyosomes are distributed in the cytoplasm. Most of these lie outside the spindle plate in the early anaphase (fig. 1). At a little later stage (fig. 2), some have invaded the spindle plate. In the late anaphase (fig. 3), the greater number of them arrange themselves along with the mitochondrial threads. Later, apparently one-half of them move toward the clear space on the equatorial side of each chromosome plate (figs. 5, 6, and 8). When the two daughter cells separate, each carries with it a certain number of dictyosomes. The dictyosomes assorted to each cell migrate close to the periphery of the nucleus (fig. 9), where they fuse to form a comparatively large darkly staining body (figs. 10 to 13). At first this mass of dictyosomes is not applied to the nucleus; but later, as the nucleus increases in size, it gradually comes in contact with it (figs. 12 and 13). When the nuclear membrane appears, the mass of dictyosomes is found lying against its outer surface with a small vesicle already differentiating from it (fig. 14). Soon this vesicle becomes enlarged and more evident (figs. 15 and 16). It is the spermatid acroblast.

The structure of individual dictyosomes may be distinguished in many of the stages described. They consist of a darkly staining or chromophilic part and a nonstaining or chromophobic part. The chromophilic part has the shape of a crescent, without any visible horns extending from the ends. It only partially incloses the chromophobic part (figs. 1 to 4). The number of dictyosomes found in the second maturation division varies from six to twelve, but the most probable number is the latter, as that is the one most frequently met with in many of the stages described.

All of the stages described above are of short duration. Throughout the formation of the nebenkern the centriole, always surrounded by a hyaloplasmic area, is invariably found to be approximately opposite that of the forming nebenkern.

SPERMATID TRANSFORMATION

The stage shown in fig. 14 may be taken as representing the completion of the spermatid as a cell and the beginning of the transformation of the spermatid into the mature spermatozoön.

The nucleus.—The nucleus as previously described has reached its maximum size at this stage. It measures approximately twice the diameter of the nucleus at the time of the separation of

the two daughter cells. From this stage the nucleus slowly decreases in size until it reaches the stage just before it elongates (fig. 33). The chromatin patches continue to disintegrate into smaller masses, which in turn break down into small pieces and granules (figs. 15 to 18). Later these chromatin pieces and granules are distributed just beneath the nuclear membrane, leaving the center of the nucleus almost clear (figs. 19 to 21). Shortly after this, chromatin threads invade the clear space, and in many spermatids large chromatin patches of varying size also make their appearance. These large patches of chromatin are the products of the disintegration of the accessory chromosome. Figures 18 and 21 show two spermatids in which the accessory chromosome begins to disintegrate. The remnants of the accessory chromosome are connected with one another by chromatin threads. Many of these threads extend from the periphery of the nucleus, where the concentration of chromatin granules is greatest, into the central area (figs. 22 to 30). Later the remnants of the accessory chromosome rapidly break down into small pieces, while the central vacuoles round out. Very often a large chromatin granule, which is a persisting remnant of the accessory chromosome, is found in the center of many of them (figs. 32 to 34). The nucleus reaches its minimum spherical size just before it elongates (figs. 32 and 33). Then it begins to elongate (figs. 34 and 35), and flattens out rapidly like a paddle (figs. 36 to 38). During these processes of elongation and flattening, the nucleus loses its symmetry, for one side elongates and flattens out faster than the other, which bulges out instead. During this stage of development the chromatin granules continually shift their position until they finally form a ring in the center of the nucleus. This ring gradually becomes flattened and elliptical. It is surrounded by the nonstaining or oxyphilic part of the nucleus, which forms the central clear space of the nucleus in the earlier stages of the transformation. Figures 35 to 38 will give a much better idea of the changes in the nucleus than can possibly be conveyed in a detailed description. The elongation of the nucleus proceeds, while at the same time the granular structure of its basichromatin part disappears, with the exception of a small portion at the anterior end, which still remains granular (figs. 39, 43, and 44). Soon the entire basichromatin part becomes more and more compact and finally becomes homogeneous and stains very intensely in the last stages of the transformation. No elimination of a nuclear substance into the cytoplasm has been observed during the whole process.

The final product of the transformation of the spermatid nucleus is the solid deeply staining fusiform sperm nucleus (fig. 47). Figure 48 represents a cross section of two sperm nuclei.

The nebenkern.—After the mitochondria have aggregated into an apparently homogeneous mass (fig. 14), a rapid process of vacuolization takes place. A few vacuoles appear at first just beneath the periphery. Each is separated from the others by a ring of chromophilic substance (fig. 16). Then the vacuoles coalesce to form a few larger vacuoles, which are separated one from the other by a chromophilic septum. The septa radiate from a darkly staining center to the outer ring (fig. 17). These septa soon disappear, and a condition like that shown in fig. 18 results. The nebenkern now consists of a chromophilic center, surrounded by a chromophobic part. Very often small vacuoles are found in the chromophilic central substance. The stage shown in figs. 18 and 19 persists for a long time and may be called the resting stage of the nebenkern. Following this it elongates and approaches the axial filament until it comes to lie parallel with it. Then its central core vacuolizes (fig. 20) and continues to elongate. Later it divides, one-half sheathing one side of the axial filament and the other half the other side (fig. 21). At first large vacuoles are found in its component parts; but, as it elongates more and more, it breaks down into smaller pieces and the vacuoles disappear (figs. 25 to 27). The elongation seems to be associated with the lengthening of the axial filament, for, as the latter structure increases in length, the nebenkern trails it (figs. 29 and 32). In the later stages of the nebenkern, "blebs" appear in it, which are pushed down as the spermatozoön is about to reach its final development, and form a large protoplasmic ball at the posterior end of the flagellum (fig. 44). This protoplasmic ball is finally cast off as the spermatozoön becomes mature. The final product in the metamorphosis of the nebenkern is a sheathlike structure, which forms the outer covering of the flagellum of the mature spermatozoön (fig. 47).

The acroblast and the acrosome.—The acroblast arises, as we have said, as a small vesicle differentiated from the dark mass of dictyosomes lying against the nuclear membrane near the nebenkern. This structure rapidly increases in size and assumes a rounded shape. It stains heavier on the side close to the cell wall, and is always in contact with the dictyosome mass from which it is differentiated (fig. 16). It then begins to migrate

around the nucleus. During the process of migration it gradually increases in size (figs. 17 to 23). After its migration around the nucleus, it stops at its original position and remains stationary for a long time, and again increases in size. It appears to stain very lightly at this stage (figs. 24 and 25). Later the acroblast rapidly separates from the rest of the dictyosome mass, which has become diffused now, and disappears in the cytoplasm. Figures 26 to 28 show three stages in the separation of the vesicular acroblast (acroblast remnant) from the diffused mass of dictyosomes. Figure 29 shows the remnant of the acroblast passing down the tail region. Meanwhile the rest of the dictyosome mass, which lies against the nuclear membrane, becomes diffused and loses its strong affinity for nuclear stains as it increases in size (fig. 25). Later it becomes distinctly demarcated from the separating acroblast, and rounds out (figs. 26 and 27). At this time vacuoles appear in it. These vacuoles coalesce to form larger vacuoles, which increase in size and produce a large vesicle in the center of which is a darkly staining granule (fig. 28). The vesicle and the granule found in it form the acrosome complex. The vesicle and the granule rapidly increase in size as they move toward the apex of the nucleus, opposite the centrioles (figs. 29 and 30). After the acrosome complex has reached the point opposite the centrioles, the cell's axis straightens. Thus, the centrioles become definitely located at the posterior end of the nucleus, and the acrosome complex at the anterior (fig. 32). The acrosome complex soon flattens out against the nucleus. Meanwhile the granule of the complex augments in size, while the clear vesicle begins to show distinct affinity for basic stains (fig. 33). As the nucleus elongates and flattens out, the acrosome complex, which now stains homogeneously, extends for some distance around its anterior end, forming an intensely staining caplike structure (figs. 34 to 38). Later the caplike structure (acrosome) becomes horseshoe-shaped (fig. 39). Then it assumes the shape shown in fig. 40. At a little later stage (fig. 43) a marked change occurs in it. It no longer stains uniformly, its median portion staining only slightly, while the part on either side plus a small anterior portion remain deeply stained. However, this difference in staining reaction disappears when the acrosome passes into the last stages of its transformation (figs. 44 and 47), and the spermatid becomes a mature spermatozoön. As shown in figs. 44 and 47, the acrosome loses most of its strong affinity for stain. It is only slightly chromophilic now. Its final defin-

itive shape is in the form of an A without the bar or like an inverted V.

The centrioles and the axial filament.—After the separation of the two daughter cells in the last maturation division, the spheroidal centriole, surrounded by a hyaloplasmic area, appears on that side of the spermatid opposite the chondriosome mass (fig. 9). As the chondriosome mass condenses and rounds out, the centriole maintains its position in relation to this structure; that is, it is always found approximately opposite the chondriosome mass (figs. 10 to 13). After the nebenkern has been formed, the centriole, now in contact with the nucleus, begins to move toward it (fig. 14). At this stage it is hard to tell whether or not the centriole has divided, because it is closely associated with a darkly staining mass of nuclear substance, which lies just beneath the nuclear membrane (figs. 16 and 17). In later stages, however, the centriole is seen already divided into proximal and distal parts, apparently equal in size. There is a very fine granule, scarcely thicker than the axial filament on which it is lying, a short distance from the distal centriole. This may be called the distal centriole derivative (figs. 18 and 19). After the nebenkern has reached the axial filament, it begins to elongate. Then the distal centriole derivative moves caudad and comes in contact with the elongating nebenkern at the posterior end (figs. 20 and 21). The centriole derivative continues to move posteriorly and is generally found at the end of the rapidly elongating nebenkern (figs. 25 and 32) up to a very late stage of the spermatid transformation when it is lost to view and its subsequent fate becomes unknown. At first the proximal and distal centrioles are nearly of the same size, but in later stages the former becomes larger than the latter (figs. 20 to 22, 27, 28, 32, and 33). When the nucleus begins to elongate, the centrioles become indistinct and are closely associated with, perhaps are, the same substance previously described in the earlier stages. This substance forms an envelope around them (figs. 34 and 35). As the nucleus becomes paddle-shaped and the break in the nuclear membrane at the posterior end becomes more evident, each centriole appears to have divided longitudinally into two (figs. 36 to 38). The position of the centrioles in relation to the basichromatin part of the nucleus as shown in fig. 36 lasts for a long time. They do not come in contact with it, but are separated by a space which is filled with very fine granules (figs. 37 to 43). In later stages the centrioles fuse, and with

the enveloping substance form a small compact mass (fig. 43). When the nucleus finally becomes solid and stains intensely, the fused centrioles come in contact with it at the posterior end to form the middle piece of the mature spermatozoön (figs. 44 and 47).

The spermatozoön.—The most mature spermatozoa found in our preparations made in the early part of summer have the following parts:

1. A large slightly staining acrosome, which resembles an inverted V. It forms the most anterior end of the spermatozoön.
2. A solid fusiform nucleus, which stains intensely with basic stains. There is no visible membrane surrounding it.
3. A small compact middle piece connected anteriorly with the nucleus and posteriorly with the flagellum.
4. A comparatively short flagellum surrounded by a delicate sheath. Its length is approximately twice that of the head.

DISCUSSION

The metamorphosis of the spermatid into the spermatozoön in *Amblycorypha* shows remarkable changes and offers many points of interest. These changes resemble in a general way those described by Sabatier (1890) in several species of Tettigoniidæ, by Otte (1907) in *Locusta*, and by Davis (1908) in *Steiroxys*. In many details, however, it differs widely from the changes described by these authors. These differences, we are inclined to believe, are due mostly to differences of interpretation.

THE NUCLEUS

The transformation of the spermatid nucleus into the sperm nucleus in *Amblycorypha* offers but one interesting point that is worth discussing. This is the differentiation of the nuclear substance into two distinct substances, one of which shows a strong affinity for basic stains, the other little or none at all. The former substance is called basichromatin and the latter oxychromatin. This differentiation, which occurs before the condensation of the nucleus to form the compact deeply staining sperm nucleus, seems to be of widespread occurrence in Tettigoniidæ. It has been partly described by Otte (1907) and by Davis (1908). The same differentiation has been described by Montgomery (1911) in *Euschistus*, by Bowen (1920) in some species of Hemiptera, and by others in other forms.

Now and again a remarkable phenomenon in the transformation of the spermatid nucleus has been reported by several investigators of insect spermatogenesis. This phenomenon is the extrusion into the cytoplasm of a lightly staining substance. Montgomery (1911) and Bowen (1922) have observed and described it. This interesting phenomenon, while perhaps of widespread occurrence in Hemiptera, does not seem to occur in Orthoptera. At least, it has not been reported in the spermiogenesis of many orthopterans thus far examined; and as far as our observations on *Amblycorypha* are concerned, there is nothing to indicate that such a phenomenon occurs in the metamorphosis of the spermatid in this insect.

THE NEBENKERN

The extensive literature on the origin and behavior of this structure has been so thoroughly reviewed by recent investigators, notably Bowen (1922), that it will not be necessary to present a detailed discussion here.

In general there are two opinions held concerning the origin of this characteristic structure in the spermatids of insects. One view maintains that the nebenkern arises from the fusion of the chondriosomes assorted to each spermatid; the other, that it originates from the direct metamorphosis of the interzonal filaments. The former view is supported by the works of such prominent investigators as Otte (1907), on *Locusta;* Montgomery (1911), on *Euschistus;* Payne (1917), on *Gryllotalpa;* and recently by the works of Bowen (1922), on several species of Hemiptera-Heteroptera; Pollister (1930), on *Gerris;* Johnson (1931), on *Oecanthus;* and M. A. Payne (1933), on several species of grasshoppers. The latter view is supported by the researches of Butschli (1871), on several species of insects; La Vallette St. George (1886), on *Blatta;* Paulmier (1899), on *Anasa;* and Munson (1906), on *Papilio.*

Our observations are in line with the view held by the first group of investigators. The nebenkern in this tettigoniid is derived entirely from the fusion and subsequent condensation of the chondriosomes.

Sabatier (1890) seems to be one of the first to observe the nebenkern in the tettigoniid spermatid. He believes this structure arises from the protoplasm (cytoplasm) and calls it "vesicule protoplasmique." What finally becomes of this vesicle, he

does not say. Since in his brief paper he neither gives figures nor describes the changes following the formation of this structure, it is impossible to compare the behavior of his "vesicule protoplasmique" with the behavior of the nebenkern in *Amblycorypha.*

Otte (1907) describes in detail the origin and behavior of the nebenkern in *Locusta.* According to his account, the greater portion of the mitochondria assorted to each spermatid fuses into a loose mass near the side of the interzonal filaments. This mass of mitochondria becomes condensed and forms the compact nebenkern, which stains darker than the cytoplasm. Later the nebenkern differentiates into two substances; namely, an inner chromophilic core and an outer chromophobic part. From the chromophilic center septa radiate and extend to the periphery of the chromophobic part. Then the nebenkern becomes homogeneous and finally elongates to form a sheath around the axial filament.

Davis (1908) fails to identify the nebenkern in the spermatids of *Steiroxys,* nor does he trace the origin of a structure that corresponds to it. He calls "Nebenkern" for convenience and "without implying anything in regard to its homologies," a darkly staining structure which lies near the nucleus (see his fig. 203.) If his "Nebenkern" corresponds to the acroblast of recent investigators, then the less deeply staining structure applied to the nuclear membrane and lying near the "Nebenkern" is probably the true nebenkern. However, if we were to interpret his figure 203, with reference to the differential staining of the two structures and their relative position in the cytoplasm, we would say the nebenkern is the same one which he calls "Nebenkern" (acroblast), and the less deeply staining body closely applied to the nuclear membrane is the acroblast.

Our observations on the origin and behavior of the nebenkern in *Amblycorypha* agree in general and in many particulars with those of Otte in *Locusta.* However, he has not mentioned a few of the early stages in the differentiation of the nebenkern into two substances. In these particulars our account resembles closely the description given by Bowen (1922), of *Murgantia,* and partly that given by Johnson (1931), of *Oecanthus.* The differentiation of the nebenkern in some hemipters, as given by Bowen, with the exception of the initial stage—namely, the appearance of many vacuoles in the periphery of the nebenkern—

is so strikingly like that of *Amblycorypha* that it could be applied almost directly. Bowen states that—

> . . . once fully completed, the nebenkern begins to show the first signs of differentiation into two substances. This first makes itself evident by the appearance of a large number of vacuoles in the periphery of the mitochondrial mass. These are at first very indistinct and difficult to demonstrate, but they presently become clearer and form a complete layer investing the periphery of the nebenkern. They seem to stain little or not at all in contradistinction to the central mass, which is more darkly colored. This may be due to the fact that the process of differentiation is going on from without inward, or it may be due to the optical superposition of several layers of vacuoles. The outermost layer clears up very rapidly, the separate vacuoles fusing together to form large clear spaces, separated from each other by septa which pass outward from the central mass to the exterior of the nebenkern which is marked by a very definite membrane. The whole thing reminds one of the figure given by Meves (1900) of Pygaera. The clearing up of the outer layer of vacuoles now proceeds rapidly, the substance of the vacuole walls apparently withdrawn into the underlying region of the nebenkern, and eventually the whole peripheral zone appears as a clear non-staining envelope, enclosing a central chromophilic core.

While the processes of the differentiation of the nebenkern into a chromophilic central substance and a chromophobic outer substance in *Amblycorypha* resemble more closely those in Hemiptera than those in *Locusta* as described by Otte, the subsequent changes in *Amblycorypha* are entirely different from those observed by Bowen and Johnson, but are similar to those described by Otte. As a whole the changes undergone by the nebenkern in *Amblycorypha,* from the time of its formation to its final fate, resemble more closely those of *Locusta* than those described either by Bowen in Hemiptera or by Johnson in *Oecanthus.* This resemblance is not surprising at all—in fact, it is what one would expect to find in such closely related genera as *Locusta* and *Amblycorypha.* It appears very probable that, if a more-detailed study of the nebenkern in *Locusta,* in the forms examined by Sabatier and in *Steiroxys* studied by Davis, were made, a condition similar to that in *Amblycorypha* would be revealed.

THE ACROSOME

No structure in the spermatids of insects has received more consideration in the past than that which forms the apex of the sperm head, commonly called the acrosome or perforatorium. This structure, which varies greatly in size and shape in diverse

groups of animals, has been traced to many different origins. In insects alone it has been described as originating from the nucleus, spindle remnants, nebenkern, Golgi bodies, idiosome, acroblast, sphere, from a combination of mitochondria and central spindle fibers, from a centrosome, and in some cases it has been derived from an obscure structure in the cytoplasm, the nature of which is not known.

Butschli (1871) appears to be the first to describe the formation of the acrosome in the tettigoniid spermatids. He derives this structure from a granulelike vesicle in the cytoplasm. This vacuole comes in contact with the nucleus and moves forward to its anterior portion to form the definitive acrosome. His observations are in line with those of many recent investigators. He fails, however, to make out the origin of this granulelike vesicle and to notice the casting off of a substance which corresponds to the so-called acroblast remnant.

Sabatier (1890) in his studies of the spermatogenesis of some locustids traces the origin of the acrosome to the "vesicules nucleaires," which arise from the direct metamorphosis of the nucleus. A fusion occurs among these small nuclear vesicles, and as a result a small number of large vesicles is produced. These large vesicles increase in size, lose gradually their affinity for stain, and diminish by a further fusion to three; namely, "un mediane, petite et saillante, et deux laterales qui s'allongent et finissent par former les deux branches ou crochets de l'ancre que constituent la coiffe cephalique."

It seems probable that Sabatier misinterprets the complicated changes occurring during the transformation of the spermatid nucleus in the locustid forms he has examined. His observations on the origin of the acrosome are entirely different from our observations on *Amblycorypha* and from those of others who have later made careful studies on the origin of this structure in closely related insects.

Otte (1907) gives a complete, as well as a most satisfactory, account of the formation of the acrosome in *Locusta*. Our account of the origin of the acrosome in *Amblycorypha*, with the exception of two important points, is in accord with his on *Locusta*. In his observations on the origin of the idiosome, the structure in the spermatid from which the acrosome originates, he describes it as arising from the direct metamorphosis of the bundle of central spindle fibers (interzonal filaments) and a portion of the mitochondria. As far as our observations are

concerned, we are quite sure that the central spindle fibers and a portion of mitochondria take no part in the formation of the acroblast in *Amblycorypha*. Here the central spindle fibers disappear after the telokinetic movements of the chromosome plates have taken place; while the acroblast makes its appearance only after it has been differentiated from the fused mass of dictyosomes lying against the nuclear membrane, long after the disappearance of the spindle fibers and the aggregation of the mitochondria into a compact spherical body. Recent investigations on this subject show conclusively that the idiosome or acroblast does not arise from the spindle fibers and mitochondria but from other structures in the cell, such as Golgi bodies and dictyosomes.

Again Otte describes the casting off of the mitochondrial substance from the idiosome after its rotation around the nucleus. In *Amblycorypha* the substance that is cast off from the forming acrosome is the rounded vesicle (acroblast remnant), which corresponds to his idiosome. In short the idiosome itself forms the acrosome in *Locusta*, while in *Amblycorypha* the acrosome is formed by the acrosome complex synthesized in close connection with the acroblast.

Davis (1908) describes the acrosome in *Steiroxys* as arising from a rounded structure which he calls, for convenience, "Nebenkern." The nature of this body he does not know. He traces the transformation of this structure into the anchor-shaped acrosome. He has not observed, however, the differentiation of the acrosome complex in close association with the "Nebenkern," and the casting off of a substance from it. He also overlooks some of the later stages of the acrosome.

Recently the origin of the acroblast and its rôle in the formation of the acrosome have been more fully studied in other insects that are not closely related to *Amblycorypha*. A brief review of the results of a few of these investigations will be given here for comparison with our findings.

Payne (1916), in his study of the germ cells of *Gryllotalpa*, like Davis, is not able to ascertain the origin of the acroblast. He observes two structures in the cytoplasm of older spermatids, one of which is elongated and curved and is in contact with the nuclear membrane, the other small and spherical. The elongated body gives rise to the acrosome, while the spherical one degenerates and disappears during the transformation. Concerning the origin of these structures, Payne says, "it would seem that

they rise de novo in the cytoplasm as they are not present in the young spermatids."

Bowen (1920 and 1922), in his study of the spermatogenesis of many hemipters describes the fused type of acroblast as originating from the fusion of the dictyosomes assorted to each spermatid. From the acroblast the acrosome complex is differentiated, after which the acroblast remnant is cast off from the acrosome complex. This complex, which consists of the acrosomic vesicle and the deeply staining granule found in it, gives rise to the definitive acrosome. This differentiation of the acrosome from the acroblast seems to be of very wide application in insects. It has been found in many of the insects thus far examined in detail.

Voinov (1925) describes the formation of the acrosome in *Gryllotalpa vulgaris*. It arises, according to him, from two structures; namely, the acroblast and the "appareil spherulaire." The acroblast arises in close association with the Golgi bodies, while the "appareil spherulaire" arises by the fusion of spherical bodies in the spermatid. This process of acrosome formation is slightly different from the condition observed by Bowen. However, both involve the acroblast as participating in the formation of the acrosome.

F. Payne (1927) in another paper finds that the acrosome originates from a large idiosome. According to his account, several small spheres, which he calls proidiosomal spheres, fuse to form a large idiosome, around which the Golgi bodies collect or aggregate. This complex corresponds to the acroblast of other investigators. However, in *Gelastocoris* the large idiosome alone is responsible for the formation of the acrosome, the Golgi bodies being cast off. Thus, while the acrosome is the product of the acroblast in the forms studied by Bowen, in *Gelastocoris* it is the product of the large idiosome. In both cases a substance is cast off from the structure that finally forms the definitive acrosome.

In *Gerris*, Pollister (1930) traces the origin of the acrosome from the acroblast. He observes that the osmiophilic Golgi materials aggregate in the young spermatid and form "an irregularly folded, sac-like structure," the acroblast. After the formation of the acrosome, the acroblast remnant separates from it and is cast off into the cytoplasm.

Johnson (1931) finds in *Oecanthus* a condition nearly like that described by Bowen. The acroblast is produced by the fusion in the spermatids of a number of dictyosomes, from which the

acrosome is apparently differentiated. Later the acroblast remnant is cast off into the cytoplasm and passes down the tail.

Our study of the results of the above investigators and many others reveals that in many cases the acrosome in insects is formed in close association with the acroblast or a structure similar to it.

THE CENTRIOLES AND THE AXIAL FILAMENT

The behavior of the centrioles during the transformation of the spermatid is so different in various groups of animals that only observations on closely related genera will be considered in this brief discussion. Those desiring a lengthy discussion on this particular subject are referred to the works of Bowen (1922), Baumgartner (1929), and Johnson (1931).

Early workers on the spermiogenesis of the tettigoniids have failed to demonstrate the presence of centrioles in the spermatids. Perhaps this is not because centrioles are not present in the objects examined, but because they are overlooked or considered insignificant or because the technic used at the time is not adequate to bring out such minute structures.

Otte (1907) seems to be the first to demonstrate the centrioles in the locustid spermatids. He traces the behavior of these bodies throughout the transformation of the spermatid. The centrioles, according to his account, are so small that they are not easily recognized. He finds two small granules near the periphery of the cell, which he assumes to be central bodies. Later these are oriented in proximal and distal positions, the larger proximal centriole lies at the nuclear membrane and the distal one at the cell wall. Between them is the intracellular axial filament and extending from the distal centriole is the extracellular axial filament. The proximal centriole is usually so closely associated with the accessory chromosome or with chromatin patches that it cannot be recognized. Later this association becomes so close that it gives one the impression, "als käme der Achsenfaden von dem akzessorischen Chromosom." When the accessory chromosome breaks down, the proximal centriole emerges and then divides laterally into two. Each of the later divides, giving rise to four centrioles. The two inner centrioles move up into the nucleus, and each again divides into two. These four centrioles resulting from the division of the two, migrate farther to the anterior pole of the nucleus and form an "Innenkörper" in the sperm nucleus. Meanwhile the

two centrioles left at the nuclear membrane elongate and take part in the formation of the middle piece. The distal centriole continues to move caudad until it disappears from view in the last few stages of the transformation.

The behavior of the centrioles in *Amblycorypha* differs greatly from that described by Otte for *Locusta*. In both genera the centrioles are similar. In both chromatin material is in close association with the centrioles in the early stages of the transformation; in both the axial filament originates from one of the centrioles; the caudal migration and final disappearance of a granulelike structure in close association with the axial filament take place in both. They are also similar in the appearance of four centrioles just as the spermatid nucleus begins to elongate and in the participation of the centrioles in the formation of the middle piece. Otte's recognition of the granulelike structure, which migrates caudad and finally disappears, is significant. This structure he interprets to be the entire distal centriole, while we believe it is only a derivative of the distal centriole. Recently Johnson (1931) finds in *Locusta viridissima*, the species studied by Otte, that it is not the entire distal centriole which migrates caudad as Otte thought, but only a derivative of this. This being the case, the four centrioles, which Otte believed to have arisen from the proximal centriole, must have come from the division of the original centriole into proximal and distal ones, each of which in turn divides into two, giving rise to four, as in *Amblycorypha*. His description of the migration of two centrioles up into the nucleus, their subsequent division into four, and their final fate to form the "Innenkörper" in the sperm nucleus, we cannot correlate with our observations. These four centrioles in the nucleus of the older spermatids in *Locusta* look more like some basichromatin granules in the center of many clear areas in the nucleus of the spermatid in *Amblycorypha*.

The behavior of the centrioles in *Steiroxys*, as observed by Davis (1908), is almost identical with that of *Amblycorypha*. However, Davis seems to have overlooked the presence of centrioles in the young spermatids. It is only when the nucleus begins to elongate that he notes the presence of these structures. Hence he does not determine the origin of the axial filament nor does he notice the presence of a granulelike structure lying on it or in close association with it. It seems probable that, if a further study of the centrioles in *Steiroxys* and *Locusta* were

made, a condition much more like that in *Amblycorypha* might be found.

SUMMARY

1. The mass of chromosomes in each daughter cell after the last maturation division breaks up into patches, which gradually become diffused through the nucleus. Later a differentiation of the nuclear material into a basichromatin substance and an oxyphilic substance takes place. From the basichromatin substance is formed the solid, deeply staining, fusiform sperm nucleus.

2. The mitochondrial substance assorted to each spermatid clumps into a mass. This mass rapidly condenses and finally rounds out to form the spherical nebenkern. The nebenkern, after undergoing many changes, differentiates into an inner chromophilic core and an outer chromophobic part, surrounded by a well-marked membrane. Later it comes to lie on or below the axial filament, elongates with this structure, and finally forms a covering around the flagellum.

3. The dictysomes in each spermatid fuse. The mass resulting from this fusion comes to lie against the nuclear membrane near the nebenkern. From it a vesicle is differentiated which increases rapidly in size to form the acroblast. The acroblast migrates around the nucleus, and, after the formation of the acrosome complex in close association with it, it is finally cast off into the cytoplasm. The acrosome complex, which consists of a vesicle containing a deeply staining granule, becomes the definitive acrosome, having the shape of an inverted V.

4. The spherical centriole divides into proximal and distal parts. From the distal centriole a derivative arises, which migrates caudad and finally disappears from view in the last stages of the transformation. Later the proximal and distal centrioles divide. The four centrioles resulting from this division participate in the formation of the middle piece.

5. The axial filament apparently originates from the central bodies, but it has not been determined whether or not it originates from the distal centriole. From it the comparatively short flagellum of the mature spermatozoön is formed.

6. The spermatozoön consists of a large inverted V-shaped acrosome, which stains lightly or not at all; a solid, deeply staining, fusiform nucleus, to the posterior end of which is attached the scarcely distinguishable compact middle piece; and

a short flagellum, which measures approximately twice that of the head.

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ILLUSTRATIONS

[All figures were drawn with a camera lucida at an initial magnification of 2,700, and the drawings retouched freehand.]

AMBLYCORYPHA OBLONGIFOLIA (DE GEER)

PLATE 1

FIGS. 1 to 3. Anaphases of the second maturation division. Mitochondria near the cell wall and dictyosomes scattered along the spindle plate.

FIG. 4. Cross section of cytoplasm at the stage shown in fig. 3, showing the distribution of mitochondria.

5. Late anaphase; showing short and long mitochondrial threads, also the small dictyosomes at both ends of the disappearing spindle fibers.

6. Telophase; the number of long mitochondrial threads increases.

7. Cross section of cytoplasm at the stage shown in fig. 6, showing the distribution of mitochondria.

8. Telophase.

FIGS. 9 to 14. Successive stages in the condensation of mitochondrial substance to form the nebenkern. Note also the dictyosomes.

FIG. 15. Early spermatid; showing nebenkern, axial filament, and small vesicle differentiating from the dictyosome mass.

FIGS. 16 and 17. Two spermatids with fully formed acroblast; nebenkern differentiating into two substances.

18 and 19. Spermatids at a little later stage; centriole divides into proximal and distal parts. Note centriole derivative a short distance from the distal centriole.

20 to 24. Later spermatids; nebenkern starts elongating; centriole derivative at its posterior end; acroblast moving around the nucleus and increasing in size.

PLATE 2

FIG. 25. Late spermatid; dictyosome mass becomes diffused from which acroblast begins to separate.

FIGS. 26 to 29. Stages in the formation of acrosome complex.

30 to 33. Note increase in size of acrosome complex.

FIG. 34. Elongation of nucleus; flattening of acrosome complex.

FIGS. 35 and 36. Later stages. Note caplike acrosome and paddle-shaped nucleus and division of centrioles.

37 to 39. Slightly later stages.

FIG. 40. Note nucleus and acrosome; basichromatin of nucleus becoming compact.

FIGS. 41 and 42. Cross sections of flagellum and nucleus, respectively, at the stage shown in fig. 40.

FIG. 43. Very late stage in the transformation. Note change in staining reaction of acrosome.

44. Nearly mature spermatozoön; acrosome stains lightly and uniformly; nucleus very compact except at anterior portion. Note protoplasmic ball at posterior end of flagellum and also undulating membrane on each side of the nucleus.

45. Side view of spermatozoön at the stage shown in fig. 44.

46. Cross section of solid nucleus.

47. Mature spermatozoön.

FIGS. 48 and 49. Cross sections of nucleus and flagellum, respectively, of mature spermatozoön.

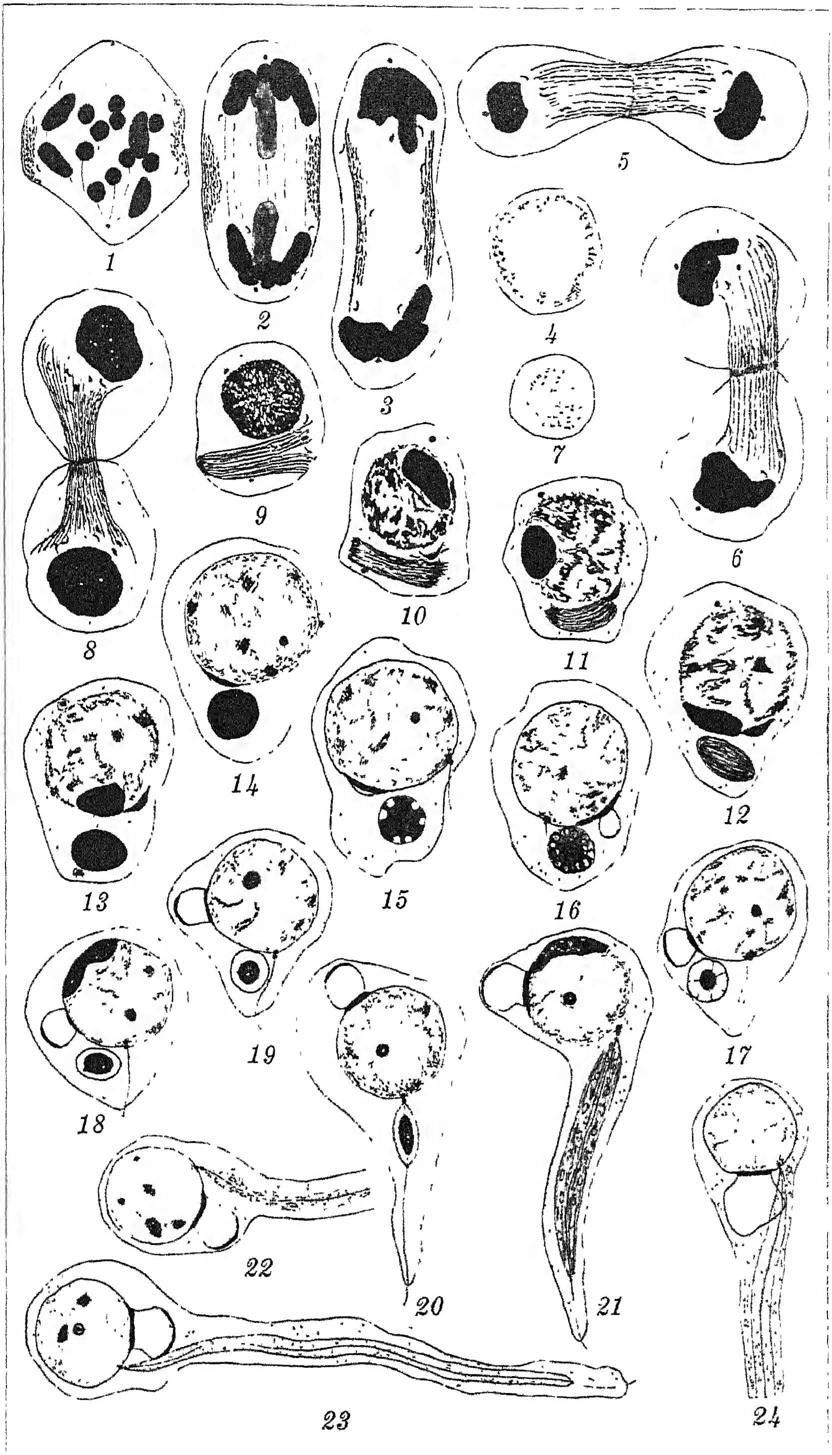

PLATE 1.

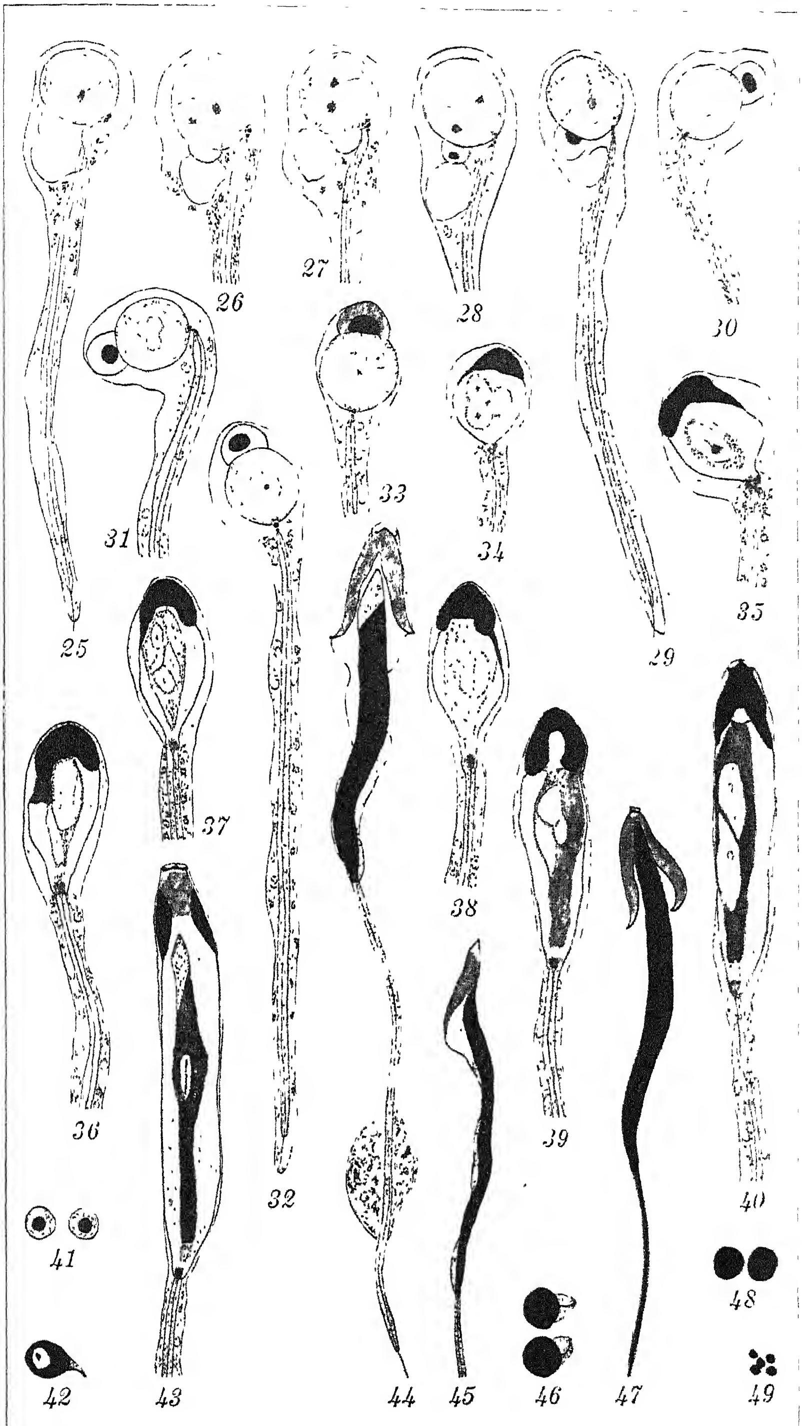
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PLATE 2.

FAUNA PHILIPPINENSIS (PLATYPODIDÆ ET SCOLYTIDÆ), III

By KARL E. SCHEDL

Of Vienna, Austria

PLATYPUS PHILIPPINENSIS Blandf.

Female.—Nearly black, 6.20 mm long, 4 times as long as wide.

Front flat, epistomal margin and the median line up to the center shining, polished, and with a few small punctures; anterior half densely punctured, subopaque and areolate above.

Pronotum shining, 1.29 times as long as wide, widest behind the lateral emarginations; the latter shallow; median sulcus long and fine, surrounded by cordiform patch of densely placed and uniform-sized punctures, the patch longer than wide; surface with small, sparingly placed punctures.

Elytra but little wider than the pronotum (16 : 15.5) and 2.31 times as long, sides parallel, rather narrowly rounded behind; striate-punctate, with the exception of the eighth all striæ impressed, punctures of the first and ninth striæ confluent on the greater part of their length, striæ two to seven with rather large and deep punctures, the eighth striæ with the punctures small, shallow and remotely placed, interstices subconvex and impunctate, base of the third widened and with a long row of densely placed transverse rugæ; declivity rugose and hairy, convex above, perpendicular below. Abdomen normal.

Types in the possession of Mr. F. C. Hadden and in my own collection. The female is here described for the first time.

Locality.—Mount Maquiling, Laguna Province, Philippine Islands (*Bautista*). Under bark of malugai, *Pometia pinnata* Forst.

PLATYPUS HYBRIDUS sp. nov.

Male.—Nearly black, 6.30 mm long, 3.04 times as long as wide. A very distinct species of the group *Platypi sulcati.*

Front opaque, depressed medially, densely areolate; antennal scape longer than wide.

Pronotum quadrate, shining, widest behind the moderately deep lateral emarginations, coarsely moderately densely punc-

tured; median sulcus fine and long, in front of the sulcus surface impunctate.

Elytra as wide and 1.95 times as long as the pronotum, sides parallel, broadly rounded behind, striate-punctate, striæ very narrow and very deeply impressed on the anterior two-thirds, becoming shallower to obsolescent towards the apex, interstices convex near the base, gradually flattening out caudad; in front of the first four interstices a narrow transverse area covered with transverse rugæ, the interstices shining and sparsely punctured on the basal fourth of their entire length, opaque and rather densely covered with irregularly placed, deep, shining punctures behind, the punctures becoming more numerous and shallower towards the apex, with rows of reddish hairs; cylindrical, declivity convex and flattened on an equilateral triangular areas as in some species of *Xyleborus*, near the upper corner with a granule in the prolongation of the second interstice; a few more but smaller granules on the flattened portion below. Abdomen normal.

Type in my collection.

Locality.—Philippine Islands. Collected from anang, *Diospyros ahernii* Merrill.

PLATYPUS SPECTABILIS sp. nov.

Female.—Dark reddish brown, the anterior half of the elytra paler, 6 mm long, 2.95 times as long as wide. This species shows characters of the pronotum that have not been known in other species of the family. Preliminarily I place it in the *Platypi sulcati*.

Front plano-concave, depressed in the center, subopaque, subimpunctate on the anterior third, areolate above, lateral margin towards the articulation of the antennæ raised and longitudinally wrinkled. Antennal scape longer than wide.

Pronotum quadrate, lateral emarginations weakly developed, surface shining and with scattered fine punctures; median sulcus long, extending nearly to the middle of the pronotum, with a cordiform patch of rather large, deep punctures around it; the patch much longer than wide, transverse in front, anterior to this patch with a group of nine to twelve large pores on each side of the median line, the outer line of these pores is semicircular on one side, nearly quadrate on the other.

Elytra little wider than the pronotum (21 : 19.5) and 2.05 times as long, the base feebly carinate, sides subparallel, broadly rounded behind; surface shining on the anterior two-thirds,

subshining behind; sulcate, sulci narrow, irregularly uniseriately punctured, disappearing towards the declivity; interstices convex on the shining portion, flat behind, with fine, widely scattered punctures; the ninth interspace densely, roughly punctured, base of interstices two to five transversely rugose, more strongly on the third; declivity commencing behind the anterior two-thirds, feebly convex at first, perpendicular behind, the perpendicular face triangular, the entire declivity covered with extremely crowded small shining punctures on an opaque surface and with numerous short yellow hairs. Abdomen normal.

Type in my collection.

Locality.—Philippine Islands. From lumbayao, *Tarrietia javanica* Blume.

CROSSOTARSUS SUBDEPRESSUS sp. nov.

Male.—Dark reddish brown, declivity black, 4.56 mm long, 3.13 times as long as wide. Belonging to the group *Crossotarsi subdepressi* this species is easily recognized by the noncarinate interstices on the upper convexity of the declivity and the characters of the last abdominal sternite. The latter is opaque and has a rather deep emargination on the caudal margin, thus forming a lateral bluntly rounded edge on each side.

Front narrowly depressed above the epistomal margin, convex above, entirely opaque, with a small shining puncture in the center and a few scattered punctures towards the vertex.

Pronotum brightly shining, slightly longer than wide 15 : 14), widest behind the rather shallow lateral emarginations; median sulcus weakly developed, with scattered fine punctures; a few coarser ones at both sides of the median line in front of the sulcus, densely but finely punctured on a narrow strip along the basal margin.

Elytra slightly wider than the pronotum (15 : 14) and 1.80 times as long, widest a short distance behind the middle, sides subparallel, broadly rounded and with a semicircular emargination behind; base carinate, surface shining, striate-punctate, striæ impressed, less so laterad, strial punctures small and confluent on the first five striæ, punctures little more remotely placed at the sides, interspaces flat, with scattered fine punctures on the disc, punctures becoming very densely placed towards the base and the sides; declivity commencing in the posterior third, uniformly strongly convex, with a lunate nearly perpendicular depression below; the shining interstices, which are of equal width, cease suddenly but without any armature

at the upper limit of the declivity; the latter opaque with rows of yellow hairs, the upper limit of the lunate depression developed as a feebly raised line; the lateral processes with one or two small spinules on the outer margin.

Female.—Reddish brown, pronotum and basal part of the elytra paler, 4.75 mm long, 3.37 times as long as wide.

Front flat, with a hump-shaped elevation in the center; surface opaque, with few scattered punctures in front and shallow strigose punctures behind; angle separating the front from the vertex acute.

Pronotum longer than wide (15.5 : 13.5), lateral emarginations shallow, surface shining, minutely reticulate, and with widely scattered punctures; median sulcus fine and long, surrounded by an oval patch of densely placed punctures, with a depression on each side of the median line in front of the sulcus.

Elytra wider than pronotum (14.5 : 13.5) and twice as long, sides parallel, with a lunate emargination behind; sculpture as in the male but the punctuation not so deep; the lateral processes shorter and simple. Abdomen normal.

Types in the possession of Mr. F. C. Hadden and in my collection.

Localities.—Mount Maquiling, Laguna Province, and Quezon Park, Tayabas Province, Luzon, Philippine Islands; F. C. Hadden, collector. From *Ficus* sp., and hagimit, *Ficus minnahassae* (Teysm. and De Vr.) Miq.

CROSSOTARSUS OCTOCOSTATUS sp. nov.

Male.—Reddish brown, declivity darker, 3.88 mm long, 3.33 times as long as wide. A member of the group *Crossotarsi subdepressi* with the interstices 1, 3, 5, 7 costate on the upper convexity of the declivity.

Front flat, shining, subimpunctate below, rugosely and longitudinally punctured above, with an elevated carina from the center towards the vertex, interrupted for a short piece above the center, upper surface rather densely hairy.

Pronotum longer than wide (38 : 33), lateral emarginations shallow; median sulcus short and very fine; surface shining, finely punctured; punctures rather densely placed near the apical margin, scattered and inconspicuous behind.

Elytra wider than pronotum (36 : 33) and 1.78 times as long, sides subparallel, broadly emarginate behind; disc very finely lineate-punctate, punctures hardly visible at the sides; interstices flat and impunctate, somewhat convex near the base where the

third is conjoined with the first and fifth, base of the third without any remarkable punctuation; declivity commencing in the posterior third, convex above, perpendicular and with a lunate depression below, the lateral processes bent backwards and downwards, the interstices 1, 3, 5, 7 costate on the anterior half of the upper convexity, nearly horizontal and then abruptly ceasing, the other interstices low, ending at the commencement of the carinæ, the rest of the convexity opaque, all interstices continued as low ridges which are covered with a row of setose granules, the first spined at the upper border of the shining and impunctate lunate depression, the lower margin of the latter with a small tooth between the suture and the lateral process, the process with a slender spine at its apex. Abdomen normal.

Female.—Colored as the male, 3.97 mm long, 3.26 times as long as wide.

Front as in the male but a little more convex, punctuation and median carinæ finer.

Pronotum subquadrate (37 : 35) but of the same sculpture as in the male.

Elytra but little wider than pronotum (36 : 35) and 1.80 times as long, sides parallel on the anterior half, narrowed behind, transverse at the apex; disc with sculpture similar to that in the male but still finer; the base of the third interstice with a few minute granules; declivity opaque, densely hairy and feebly convex above, with a shining, lunate, perpendicular depression below; lateral processes blunt. Abdomen normal, convex.

Types in the possession of Mr. F. C. Hadden and in my collection.

Locality.—Mount Maquiling, Laguna Province, Philippine Islands; F. C. Hadden, collector.

CROSSOTARSUS CONCAVIFRONS sp. nov.

Female.—Reddish brown, 4.17 mm long, 3.30 times as long as wide. A remarkable form, which is easily recognized by the characters of the front. I cannot place it in any group until the other sex is known.

Front with a transverse, deep impression behind a narrow epistomal margin, the concavity extending up to the lower margin of the eyes at the sides, much less so in the center; a plush of long erect hairs on each side of the epistomal margin shortly in front of the antennal articulation; the concavity shining, the upper half of the front convex and densely covered with very long, erect, yellow hairs, abraded in one of the specimens; an-

tennal scape about as long as wide, with a fringe of hairs on its outer margin, the longest of which are three times as long as the scape.

Pronotum subquadrate (39 : 37), rather feebly convex, lateral emarginations rather shallow, surface shining, with three more or less distinct depressions on each side of the median line, median sulcus fine, surrounded by a circular patch of densely placed, fine punctures which rather gradually become coarser and less densely placed at the extreme margin; the remaining surface rather coarsely and moderately densely punctured and with a pubescence that is denser than in most Platypodidæ and resembles that of *Cenocephalus pusillus* Schedl.

Elytra wider than pronotum (40 : 37) and 1.79 times as long; base finely carinate, sides parallel on the anterior two-thirds, narrowed along the upper convexity of the declivity, transverse behind; striate-sulcate, sulci indistinctly multipunctate; interstices convex, the first narrow and with a row of tubercles on its entire length, the others with sparsely placed fine punctures, the punctures coarser and denser on the second, base of the third with a long row of crowded, round, fine granules; declivity convex, with granulate interspaces; shallow sulci and reddish pubescence above, with a perpendicular finely rugose face below, a plush of reddish hairs on the latter. Abdomen normal.

Types in the Zoologisches Museum in Hamburg and in my collection.

Locality.—Philippine Islands.

CROSSOTARSUS COLEOPTRATUS sp. nov.

Male.—Black, 4.75 mm long, 3.37 times as long as wide. The third male known of the group *Platypi coleoptrati.*

Front flat, hardly visibly impressed below, subshining, punctured on a triangular space below, coarsely, longitudinally wrinkled above, with a short, median, impressed striga.

Pronotum 1.23 times as long as wide, shining, with a very long median sulcus, which is continued anteriorly by an impressed line, coarsely uniformly punctured all over.

Elytra wider than pronotum (14.5 : 13.2) and 1.84 times as long, base carinate, disc striate-sulcate, sulci narrow, indistinctly punctured, all interstices equal, strongly convex, narrow, subimpunctate; the ninth interstice densely irregularly punctured, near the base the sulci but little wider and more distinctly and densely punctured; declivity rather steep, truncate, subconvex, with three processes on each side, the apices of the median lower pair as widely separated from each other as the first process

from the second, the third much closer to the second and formed by the carinate ninth interstice which terminates abruptly at the lateral margin of the declivital convexity, the first and fourth interstices decreasing in height and width towards the upper declivital margin, the others carinate and terminating abruptly at the commencement of the truncate declivity, the latter shining and the interstices continued as rows of coarse granules. Abdomen normal.

Type in my collection.

Locality.—Philippine Islands.

STENOPLATYPUS ORNATICEPS sp. nov.

Male.—Nearly black, 4.26 mm long, 3.52 times as long as wide. The only relative of this species known may be *C. taiheizanensis* Mur., from Formosa, which must be transferred to *Stenoplatypus* Strohm. It differs from the latter by the presence of spines on the abdominal sternites and in the armature of the declivity.

Front feebly convex, subopaque, with a few round punctures in front, longitudinally wrinkled behind.

Pronotum slightly longer than wide (38 : 35), shining, median sulcus hardly visible, with very fine and very sparsely placed punctures.

Elytra wider than pronotum (37 : 35) and 1.86 times as long, striate-punctate, sutural striæ impressed, others near the base and apex only; strial punctures indistinct to obsolescent; interstices convex towards the base and apex, with scattered very fine punctures, not remarkably stronger near the base; declivital armature similar to that in *C. taiheizanensis,* but the fused first and second interstices forming a long blunt tooth, third and fourth subequal in length, the third broad and blunt, the fourth very narrow and without apical tooth; the lateral process consisting of a large blunt external and two small inner teeth; the apical margin without armature; the third and fourth visible abdominal sternites with two widely separated pointed teeth, those of the fourth sternite being much larger.

Female.—Nearly black, 4.36 mm long, 3.46 times as long as wide. A single specimen from an old collection and also originating from Luzon, Philippine Islands, I am inclined to regard as the other sex.

Front as in the male but with the sculpture shallower.

Pronotum little longer than wide (40 : 37), shining, with a long, strongly impressed, median sulcus and with three large pores, which are situated in an equilateral triangle at each side

of the sulcus, surface with widely scattered and very fine punctures, a small group of more densely placed punctures in front of the pores.

Elytra wider (40 : 37) and 1.87 times as long as the pronotum, sides parallel, narrowed along the declivital convexity, transverse at the apex; sculpture similar to that in the male, the striæ becoming obsolescent behind; the base of the third interstice densely punctured and with some indications of low transverse ridges; declivity convex above, perpendicular below, rugose and with short yellow pubescence. Abdominal sternites convex and unarmed.

Types in the possession of Mr. F. C. Hadden and in my collection.

Localities.—Males, Mount Maquiling, Laguna, Luzon, Philippine Islands, F. C. Hadden, collector; female, Luzon.

XYLEBORUS PERPILOSELLUS sp. nov.

Female.—Reddish brown, 2.37 mm long, twice as long as wide; closely allied to *X. punctulatus* Egg. but stouter and much more densely pubescent.

Front opaque, convex, indistinctly punctured except on the epistomal margin where the punctures are deeper, finer, and more densely placed. Eyes strongly emarginate in front; antennal club distinctly wider than long.

Pronotum globose, 1.26 times as wide as long, base transverse, posterolateral angles not rounded, rectangular; sides parallel on the posterior third, evenly broadly rounded in front; anterior margin not armed; summit behind the middle, anterior area finely asperate, posterior area subshining, minutely reticulate and densely finely punctured.

Elytra wider than pronotum (39.5 : 38) and 1.56 times as long, sides parallel, broadly rounded behind, convex from the base to the apex, apical margin not acute but rounded; the entire surface densely, finely, and irregularly punctured and with a fine, dense, yellow pubescence.

Types in the possession of Mr. F. C. Hadden and in my collection.

Locality.—Mount Maquiling, Laguna Province, Luzon, Philippine Islands, F. C. Hadden, collector.

XYLEBORUS FASTIGATUS sp. nov.

Female.—Reddish brown, elytra darker, 2.72 mm long, 3.34 times as long as wide. A small species of the general shape of *X. amphicranoides* Hag.

Front subshining, plano-convex, with a narrow, shallow, transverse depression between the eyes, which is interrupted by a low longitudinal elevation, finely, deeply, and densely punctured on the epistomal margin and towards the eyes, impunctate along the median line, more sparsely and shallowly punctured above.

Pronotum shining, 1.20 times as long as wide, base transverse, posterolateral angles rounded, sides parallel on the anterior two-thirds, rather broadly rounded in front; summit before the middle, anterior area densely finely asperate, polished, finely and moderately densely punctured behind, impunctate along the median line.

Elytra as wide and 1.75 times as long as the pronotum, sides parallel on more than the anterior three-fifths, then rather obliquely narrowed, deeply emarginate at the suture; disc shining, lineate-punctate, striæ not impressed, consisting of regularly placed moderately fine punctures, those of the sutural striæ somewhat coarser, interspaces flat and covered with an irregular row of finer punctures; declivity commencing at the middle, concave as in *X. amphicranoides*, concavity subshining, subimpunctate, the suture elevated, lateral margin armed with two large slender spines, which are directed backwards, the first pair situated at the anterior fourth, the second pair at the middle of the declivity; second pair but little larger than the first, cephalad to the first spine with a pair of small sutural teeth and two pairs of small setose tubercles; the apical emargination deeper than wide; the lateral processes with a small tooth, which is directed inwards on the inner margin, the outer one with a row of setose tubercles, the apices pointed.

Types in the possession of Mr. F. C. Hadden and in my collection. The specimens bear the label: Acc. No. 195, Sch. of For. Univ. P. I.

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ANATOMY AND MORPHOLOGY OF THE BUÑGA AEGINETIA INDICA LINNÆUS [1]

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TEN PLATES

INTRODUCTION

Although many papers have been published on the "buñga" (*Aeginetia indica* Linnæus), an important orobanchaceous root parasite [2] in the Philippines, it seemed desirable to undertake a study on the anatomy and morphology of the vegetative and reproductive organs of this plant because of the harm it is doing in sugar-cane fields in some parts of the Islands, especially Batangas and Laguna.(8, 22, 36, 37) In Calamba Sugar Estate nearly a fourth of the total area devoted to sugar cane is more or less heavily infested with this parasite. Needless to say it is a serious problem and a source of no little worry to the administration. Buñga reduces the sugar content of the canes very considerably(36) and may even cause the formation of substances that render the canes unfit for milling.(22) The present paper is an attempt to describe those phases of the anatomy of the buñga which form a background for a physiological study, and it is hoped this study will result in the development of a basic method of control.

[1] College of Agriculture Experiment Station contribution, No. 1023. Read before the Los Baños Biological Club, July 26, 1934.

[2] This plant is believed to possess medicinal properties by people in some towns of Batangas, where it is said to be cultivated to some extent.

According to Bakhuizen van den Brink,(3) this plant is now found in British East India, Java, New Guinea, Borneo, Philippine Islands, Japan, and China, growing on roots of the Gramineæ, and a few of the Cyperaceæ, Zingiberaceæ, Cannaceæ, Gleicheniaceæ, and Ericaceæ. In the Philippines, buñga is distributed in Luzon from Cagayan to Sorsogon, in all or most provinces, and in Leyte and Panay. It grows in these regions on various coarse grasses at medium altitudes.(35) In Rizal(22) and Negros,(8, 22, 37) as well as in Laguna, this parasite is mostly confined to sugar-cane plants.[3]

Kusano(28) traced the development of the primary tubercle and the primary roots of *Aeginetia indica* Linn.[4] in Japan, and he found that this parasite subsists generally on wild grasses (*Miscanthus sinensis* Anders. and *Carex lanceolata* Boott.) and a few cultivated plants [*Zingiber mioga* Rosc., a mountain rice (*Oryza sativa* Linn.), *Setaria italica* Kth. var. *germanica* Trin., *Zea mays* Linn., *Panicum miliaceum* Linn., and *Panicum frumentaceous* Linn.]. His observation showed that its subterranean parts seem to winter in the vicinity of Tokyo in much the same way that it ratoons with the canes in the Philippines (Plate 9, fig. 90). The seed, according to Kusano, upon germination sends out first a filamentous radicle, its end swelling to form a primary tubercle, when proper host roots are present. Macroscopically he observed that the front of this tubercle penetrates into the cortex of the host root and becomes organically connected with the latter, there differentiating into a primary haustorium. On the upper end the growing point of the stem develops. Simultaneously with the formation of the stem, numerous processes appear from the tubercle as roots of the parasite; these organs possess neither root hairs nor root caps.

[3] February 3, 1934, Mr. Emiliano F. Roldan, of the College of Agriculture, submitted for identification a grass (*Paspalum scrobiculatum* Linn.), which possessed young tubercles of the buñga. This grass, according to Mr. Roldan, was artificially inoculated in a pot of soil. The writer grew this same grass and several other graminaceous weeds, and these were inoculated with seeds of the buñga March 7, 1934. March 28, 1934, the following weeds showed the presence of young tubercles of various sizes from pinhead to about 5 millimeters in diameter: *Eleusine indica* (Linn.) Gaertn., *Eragrostis amabilis* (Linn.) W. and A., and *Paspalum scrobiculatum* Linn.

[4] The English résumé by the author was published by Roxas.(36)

He further stated that both stem and root are formed endogenously.

Later Kusano(29) performed extensive germination experiments on the seeds and he described in detail early stages of germination and development of the young seedling. According to this investigator the seeds did not germinate when immersed in chemicals, and direct contact with the host roots was by no means an indispensable condition in bringing them to germinate. Plants found to induce seedlings to form tubercles were: *Luzula campestris* DC. var. *capitata* Miq., *Carex japonica* Thunb. var. *chlorostachys* (Don) Kük., *C. morrowi* Boott., *Miscanthus sinensis* Anders., *Calamagrostis arundinacea* Roth., *Setaria excurrens* Miq., *Oryza sativa* Linn. (upland form), *Panicum miliaceum* Linn., *Pollia japonica* Hernst., *Zingiber mioga* Rosc., and *Canna indica* Linn. He also found that dry seeds lose viability in two years in Japan.

Coert(13) has described an *Aeginetia*[5] (*A. saccharicola* Bakh.)[6] plant from Java, which appears to be similar to the Philippine buñga, except in the number of its placentas. Into Coert's description were incorporated many useful observations of the habits and growth of this Javan parasite.

McWhorter,(34) Teodoro,(46) and Roxas(36) attempted to lay out methods of control for the parasite; their recommendations were based largely on the findings of Kusano.(28, 29) Despite all these prescribed methods of combating this plant and the presence of some natural means of control, its spread remains unchecked. If control measures are not found, it may be only a matter of time before its spread will be beyond human control. Some investigators interested in its eradication have diverted themselves with the use of herbicides, or weed killers.(37) Agati and Tan(1) used Atlacide in their attempts to find an effective means of killing this pernicious plant, but they found that their herbicide only helped to prevent seedage, the underground organs remaining unharmed. Later, the same investigators(2) applied DL solution in two concentrations and salt (NaCl) in three concentrations. Their results proved that these

[5] A translation into English of the original article by the author appeared in Sugar News 9 (1928) 367–375.

[6] See Bakhuizen van den Brink.(3)

herbicides also were efficient in killing the aërial organs of the buñga, but its underground parts remained unaffected. In fact, under large scale conditions, these authors observed that new sprouts appeared after the application of the sprays.[7]

MATERIAL AND METHODS

October 13, 1933, some of the material used in this study was obtained from the cultures inoculated June 12, 1933, by Mr. Emiliano F. Roldan. Later collections were made in the Calamba Sugar Estate[8] as well as in the cane fields behind the Protestant Chapel, College of Agriculture, Laguna, in December, 1933, and from January to May, 1934. Artificial germination of seeds in both black and white sand was made in the laboratory, at the College of Agriculture. Before being inoculated, the cane seedlings (POJ 2878) were allowed to grow normally a week or two in the sand; then they were washed off carefully with water and their root systems were covered with the buñga seeds collected in December, 1933, in the Calamba Sugar Estate, and with some obtained through the courtesy of Dr. G. O. Ocfemia. From time to time individual cane seedlings were dug up to be examined for signs of germination and tubercle formation. In all cases the young cane seedlings were moderately fertilized with Nitrophoska.

In cane fields adjoining the grounds of the Protestant Chapel, College of Agriculture, from February to July, 1934, periodically, canes were observed and dug up. These observations were made prior to and after harvesting in order to determine the behavior of this plant parasite on ratoon canes as well as on newly planted cane seedlings.

[7] An endemic root parasite (*Christisonia wightii* Elm.) very closely related to *Aeginetia indica* Linn., was recently reported by Goseco (21) to infest sugar-cane varieties; namely, DI 52, POJ 2878, Badila, New Guinea 24–A, and Negros Purple, in La Carlota, Occidental Negros. According to Elmer (16) his type specimen was collected on Cuernos de Negros, Dumaguete, Oriental Negros, March, 1908, growing in rich damp ground among the tussocks of *Ammomum fusiforme* Ridl. at an altitude of about 1,750 feet. This parasite is also found in Laguna, Bataan, Negros, and Lanao, (35) growing at altitudes of from 400 to 800 meters. Attempts of the writer to grow under laboratory conditions this parasite from seeds obtained through the courtesy of Mr. Federico P. Goseco, of the Research Bureau of the Philippine Sugar Association, have failed.

[8] Thanks are here expressed for the kind coöperation and help extended to the writer by the Calamba Sugar Estate in providing him with suitable specimens of the parasite for this study.

The material, consisting of vegetative as well as reproductive organs, was fixed and killed in the laboratory with the use of formalin-acetic alcohol (70 per cent) and chromo-acetic stock solution prepared according to the formulæ given by Chamberlain.(11) It was treated in the usual fashion and embedded in paraffin. Sections 8 to 10 microns thick were cut and stained in Heidenhain's iron-alum hæmatoxylin with aniline orange G dissolved in clove oil as a counterstain. Free-hand sections of mature vegetative organs were also made, and these were stained in either Heidenhain's iron-alum hæmatoxylin, Delafield's hæmatoxylin-safranin, or safranin-light green.

OBSERVATIONS

THE ROOT

Description.—This obligate parasite possesses numerous white underground roots producing numerous tubercles or swellings, which attach themselves to the host roots by means of sucking organs, or haustoria. The roots of this parasite may be described as white, irregularly ellipsoid, rhizomatous, brittle, and delicate underground organs of small diameters. They branch freely and grow rapidly with the meshes of the cane roots in a hill. In a buñga seedling the primary roots are formed from its primary knoblike outgrowth, or primary tubercle, as was also observed by Kusano,(28) who found neither root caps nor root hairs developing from them. From a single tubercle, numerous roots as well as one to several fleshy, rather large or small, short, aërial, nonchlorophyllose scapes arise. The scapes, which may be 15 to 25 centimeters or more in height, bear few to many scalelike, rather erect, fleshy leaves; each scape is provided with few to many branches or stalks, each bearing a single terminal flower. The aërial organs, except the corolla, pistil, stamens, and seeds, are purplish, longitudinally mottled by yellowish stripes.

Anatomy.—A young root in transverse section (Plate 1, fig. 1) shows an outer layer of parenchymatous, irregularly shaped, epidermal cells, the outer walls of which are often thickened and usually brownish, with granular matter attached to them. Below this single-layered epidermis is a rather extensive cortex of parenchymatous cells, each provided with an abundance of starch grains. These cortical cells are rounded to isodiametric in transverse section and tend to become smaller towards the central cylinder; in longitudinal section they are tubular, with

their end walls set either horizontally or obliquely. The endodermis as well as the pericycle are not well differentiated. The phloëm tissue of the central cylinder has just begun to differentiate. While the endodermis of *Christisonia subacaulis* Gardn.(52) as well as of *Epiphegus virginiana*(14) is not easily distinguishable, that of *Christisonia bicolor* Gardn. is distinct, although its pericycle is not clearly differentiated(52) as it is interrupted here and there by the phloëm elements. In *Aeginetia indica* Linn., however, the cortex of the young root can be easily separated from its central cylinder by the presence of starch grains in the former and their absence in the latter.

The central cylinder of this young root is rather small, and it is devoid of starch grains as stated above. The primary phloëm rays have already differentiated (Plate 1, fig. 1), forming three distinct groups of small, isodiametric parenchyma. The ground tissue is largely composed of thin-walled parenchyma. The elements of the central cylinder are mostly elongated longitudinally with their long axes parallel to the length of the root, their end walls set either horizontally or obliquely.

As the root matures, the triarch arrangement of the vascular bundles (Plate 1, fig. 2) becomes more evident. The primary xylem consists of reticulated tracheids with thickened walls, and the rays often meet at the center of the stele so that the pith is often practically nil. The tracheids are short and rectangular, and all are of about the same size. The primary phloëm rays alternate with the primary xylem rays and are separated by parenchymatous tissue. Sieve tubes, companion cells, and parenchyma are found in the phloëm. The primary phloëm cells are all cylindrical in longitudinal section, rather long, and possess distinct nuclei, while their end walls are usually set horizontally, although obliquely set walls are not uncommon. The absence of vessels in the root is very evident; this very primitive condition of the vascular cylinder in which the xylem has become reduced and the phloëm correspondingly developed exists also in *Christisonia.*(52)

As the root reaches full maturity, it becomes somewhat tough owing to the formation of a sclerenchymatous ring around its central cylinder (Plate 1, fig. 7). The epidermal cells become tangentially flattened in transverse section (Plate 4, fig. 28), their outer walls always remaining thick with granular matter covering them on the outside. The cortical cells are likewise flattened and become somewhat spongy in character, assuming a

variety of shapes. Some of these cortical cells may be rectangular, oblong, or otherwise constricted; all contain an abundance of starch grains. The inner cortical cells of several layers in thickness are lignified, and these lignified cells may actually invaginate the central cylinder (Plate 1, fig. 7). Lignification usually takes place 2 or 3 centimeters from the apex of the root. Simultaneously with the completion of the thickening and lignification of these inner cortical cells, their stored food disappears. Some of these cortical cells may be pitted; they are usually large and variously shaped. The presence of lignified tissue around the central cylinder of the root is reported also in *Christisonia bicolor* Gardn. by Worsdell.(52)

The secondary phloëm (Plate 1, fig. 4) consists mostly of parenchymatous cells with distinct companion cells and sieve tubes. The secondary xylem is composed of groups of reticulated tracheids, the walls of which are very much thickened. These groups of tracheids are often separated from each other by a row or two of distinct parenchyma. Between the secondary phloëm and secondary xylem is an indistinct cambial layer, and this meristematic tissue does not form a complete ring around the central cylinder because of the invagination of the sclerenchymatous cortical cells. In fact, this cambium may be regarded as degenerated tissue as not much secondary thickening takes place in the root.

Occupying the central portion of the central cylinder are the primary xylem rays (Plate 1, fig. 7).

Root apex.—The apex of the root (Plate 4, fig. 30) bears no root cap, as was reported also by Kusano,(28) being entirely covered by a distinct epidermis (dermatogen). The following species are reported to lack root caps: *Christisonia subacaulis* Gardn. and *Ch. neilgherrica* Gardn.,(52) *Epiphegus virginiana*,(14) and *Cassytha filiformis* Linn.(9) Root caps are present in *Aphyllon uniflorum* Gray,(44) *Orobanche speciosa*, *O. minor*, *O. ramosa*, and *O. hederæ*.(26) The root apex of the parasite in question has the features of a typical monocotyledonous root without the root cap. The dermatogen consists of squarish to rectangular parenchymatous cells, the thin plerome, of rather much elongated, small, rectangular cells, and the periblem, of large, oblong to rectangular cells. The first covers the root, the second occupies the central portion, and the third represents the bulk of the root. All the cells of these embryonic tissues are provided with dense cytoplasm and distinctly large nuclei.

At the apex of the root may often be found a mucilagelike substance, which is perhaps essential in its growth through the soil and between the host roots.

Origin of primary and secondary roots.—The endogenous origin of the primary as well as the lateral roots as reported by Kusano(28) is herein confirmed. The writer has observed that the development of the primary root from the primary tubercle takes place rather early; that is, the root initials may be seen to differentiate in the tubercle even before the latter has attained a size of 0.5 millimeter. The primary root is first recognized, while still deep in the thin cortex of the tubercle, as a group of embryonic cells (Plate 1, fig. 8). Because of the lack of clear demarcation between the cortex and the central cylinder in the tubercle, the writer was not able to determine with absolute accuracy the particular tissue in the tubercle that gives rise to the primary root. However, these embryonic cells push themselves through the parenchymatous and starchy ground tissue of the cortex of the tubercle, and as this root initial advances outward, those cortical cells behind it gradually form the vascular bundle, which later becomes the central vascular bundle of the primary root. The front of the advancing embryonic cells, on the other hand, forms a distinct row of epidermal cells upon reaching the circumference of the tubercle (Plate 1, fig. 3). Traces of distorted and destroyed cortical cells may be seen along the front of the advancing primary root.

Development of the lateral roots in *Christisonia bicolor* Gardn. and *Ch. subacaulis* Gardn.,(52) as well as in *Epiphegus virginiana,*(14) is closely similar to that in *Aeginetia.* The lateral roots of these plants are first differentiated as a group of embryonic cells pushing out from one of the undifferentiated central bundles.(14) These cells advance through the tubercle, leaving behind a gradually forming bundle that becomes the central bundle of the lateral root. By the time this advancing group of embryonic cells has reached the periphery of the tubercle, it has formed a distinct row of epidermal cells along its apex. In some such roots the cone-shaped apex may still possess a considerable area of embryonic cells containing large nuclei and densely stained cytoplasm. Worsdell(52) states that most probably the pericycle forms the lateral roots in *Christisonia subacaulis* Gardn.

Development of secondary or branch roots in *Aeginetia* takes place very near the apex at right angles to the mother root.

The first indication of the development of a branch root is shown by the activities of the cortical cells at the region between two adjacent phloëm rays (Plate 8, fig. 83). These cortical cells acquire denser cytoplasm and distinctly stained nuclei compared with their surrounding cells, and these differentiating cortical cells become somewhat actively engaged in division at all planes so that they form a distinct strip of meristematic cells. Later, organization of the embryonic tissues of the young branch root takes place (Plate 8, fig. 84), and as this young branch root pushes itself through the cortical cells of the mother root, those cells left behind form the vascular bundles of the young branch root, similar to that obtaining in the primary root (Plate 1, fig. 3). As this root emerges from the cortex of the mother root, it forms a distinct epidermis on its front.

General consideration.—The tracheids of the stele and the sclerenchymatous cylinder of the cortex in the mature root stain red with phloroglucin-hydrochloric acid. When roots are exposed to the air, the cortex readily loses its water content, and darkening of the root takes place at once. This darkening is perhaps due to the abundant tannin in the cell sap of the cortical cells. Storage of starch grains takes place mainly in the cortex, a tissue which easily allows the escape of moisture upon exposure to air, while the sclerenchymatous cortical cylinder shuts off the central cylinder from the food supply stored in the mature root.

The cellulose nature of the outer walls of the epidermis as well as the cortical tissue of the root does not preclude the possibility that water absorption may not take place at all through this underground organ. Intake of water with dissolved mineral matter from the soil may be possible only at regions where the cortical sclerenchymatous cylinder has not yet fully developed, and this usually takes place far from its apex. In fact, Cooke and Schively(14) were even tempted to state that the roots of *Epiphegus virginiana* are also perhaps for the absorption of water.

In numerous excavations made by the writer in cane fields planted to POJ 2878 behind the Protestant Chapel, College of Agriculture, Laguna, from February to June, 1934, where this buñga was producing only one to two clusters of fresh flowers in late February, the underground organs of this parasite were found to be still fresh and connected with the cane roots. As the fruit matures, the main axis of the scape becomes dry, and

breaks off early from the fresh underground tubercle. Termites also help in mechanically detaching the scapes from the tubercles. When the canes were harvested in March, 1934, these aërial parts of the buñga were mechanically destroyed and their seeds disseminated. Some of the seeds and remains of the aërial organs might have been destroyed by fire when the trash was burned. In fields where the ratoon canes were allowed to grow, excavations made April 28, 1934, showed that the roots of the old buñga were still fresh and were attached to the cane roots (Plate 9, fig. 90), despite the fact that the fire had cleared the field of rubbish. In several instances the writer observed that even ordinary secondary roots of the parasite may start to develop scapes without first forming tubercles. What was of greater import to the writer was the development of a scape at the injured apex of the root (Plate 9, fig. 91, A). It seems quite possible that the buñga was stimulated somewhat by the heat of the fire to produce an abundance of reproductive organs. In other words, scapes are not only produced from either primary or secondary tubercles (Plate 9, fig. 91, B), as reported by Kusano,(28) but these reproductive organs may also be formed by ordinary roots of the parasite, especially in ratoon canes. Later visits to the same field showed that the buñga had actually become biennial (Plate 10, fig. 92), and perhaps would become perennial if left on the same ratoon cane for a number of years. This same behavior of the parasite has been observed in the Calamba Sugar Estate on ratoon canes (PSA 14 and POJ 2878).[9] It is apparent that ratooning canes are favorable to the perennial growth of this parasite.

Another field just as heavily infested with buñga as the one specially observed and adjacent to these ratoon canes, was planted to POJ 2878 canes April 15, 1934. The soil was well prepared, and excavations made by the writer about the middle of May, when the canes were 2 to 3 feet high, and June 14, 1934, when they were 4 feet high, showed no sign of infection, indicating that perhaps the old parasite had been completely killed, and infection must of necessity have come from old seeds.

From the foregoing anatomical characteristics of the underground organs of this parasite, the writer is inclined to believe that infestation of new seedling canes under field conditions by chips of roots detached from the host is not only improbable

[9] From the monthly report of the Calamba Sugar Estate Research Department for June, 1934.

but impossible. Infestation of these new cane seedlings must be attributed to seeds left by previous crops of the parasite. Besides, the ease with which moisture actually escapes from its roots makes it less difficult to prevent further growth of the root pieces, especially if exposed to air prior to their being carried to the roots of the new cane seedlings. In fact, the time needed to prepare the land for the next crop of cane, and the rigorous method of cultivation followed prior to planting the cane points, are enough to desiccate the roots of the parasite. True, comparatively few seeds actually germinate in nature, as a great number of them are germless, but only one seed is necessary to infect a hill of canes as the young seedling parasite can vegetate quite successfully (Plate 10, fig. 93).

It is highly probable that a tubercle or even a segment of the parasite may continue to produce roots and reproductive organs when perchance it is mechanically severed from its parent parasite, provided this severance is preceded by the establishment of organic connection between the severed segment and the host root—a point that needs further study. Otherwise, the detached part or segment will die. Infestation of nearby hills may take place if the canes are planted so near each other as to allow their root systems to overlap. In fact this parasite can grow at some distance from the hill.

In connection with the infestation of new cane seedlings by a mature parasite, the possibility of infesting new cane plants with old stumps of the parasite left attached to the old host canes must be admitted, especially under controlled laboratory conditions, where factors are made so favorable for growth. To test this possibility one would have to eliminate all the seeds clinging to the parasite and the cane stumps. This means of infestation, if possible, is, in the writer's opinion, analogous to, if not identical with, conditions obtaining in ratoon canes already infested with the parasite. While the parasite that is made to infest new canes can hibernate or even continue to produce new tubercles and reproductive organs as it has an abundance of stored food and organic connection with the old host roots is not destroyed, it can transfer to the new cane seedling in much the same way as the parasite on ratoon canes and renew its growth on roots arising from the developing buds of the old ratoon canes in the field. This phase of botanical inquiry, which awaits verification, has some important significance in the control of the parasite.

THE TUBERCLE

Kusano(29) described in detail the development of a primary tubercle soon after germination of the seed. According to him, after the hair-tendril cells are formed by the germinating seed, the cells below this filamentous radicle form a spherical or oval primary tubercle by rapid cell multiplication. This parenchymatous tissue of the young tubercle pushes and breaks the hair-tendril cells, and comes to lie in contact with the host root. Until organic connection is made, cell multiplication within the tubercle is due to the reserve food in the parasite, and Kusano claims that the young tubercle may attain the full size of about a millimeter with the help of its endosperm.

The anatomical structure of the tubercle as found by Kusano(28) is herein given. The tubercle possesses numerous vascular bundles of a peculiar appearance, and these are scattered on the ground parenchyma filled with an abundance of starch grains. Surrounding the tubercle is an epidermal layer of cells which may be broken at intervals, and these epidermal cells have their outer walls heavily stained by hæmatoxylin. At regions where the epidermis is broken or discontinuous, the outer cortical cells actually function as the epidermis. Below the epidermis is the cortex consisting of large, parenchymatous cells provided with an abundance of starch grains. This cortex is continuous with that of the main root and usually incloses the region containing the vascular bundles (Plate 1, figs. 5 and 6; Plate 2, fig. 15).

Scattered on the ground parenchyma of the central portion of the tubercle are vascular bundles. In the middle of the individual bundle (Plate 2, fig. 11) are few to numerous lignified, thick-walled tracheids with reticulate thickenings. Surrounding these tracheids are one to several layers of small, more or less elongated, parenchymatous cells, with very dense cytoplasmic content and rather large nuclei. Separating the individual small or large bundles are few to several large layers of other parenchymatous cells, with clear nuclei and not as dense cytoplasm as those found directly surrounding the tracheids. Two or more vascular bundles may fuse on entering a haustorium, while their branches diverge towards the central cylinder in the mother root. A direct connection with the central cylinder cannot be discerned; their ends appear to dip away into the cortex. The absence of a sclerenchymatous ring of cells around the central cylinder is manifest. The formation of such prominent and

peculiarly disposed vascular bundles has also been described in the tubercle of *Christisonia subacaulis* Gardn. by Worsdell,(52) who believes that their presence in the tubercle affords a good way of distributing the food absorbed from the host to points where shoot and root formation is very active.

The formation of the primary tubercle is relegated to the seedling, but that of the secondary tubercles, to the primary as well as to branch roots, and the structure of the secondary tubercle is similar to the primary tubercle. The development of the secondary tubercle is macroscopically indicated by a distinct enlargement of the secondary or primary roots—an enlargement which is often asymmetrical at first, becoming rounded later. Internally the cortical cells of the root of the parasite, adjacent to the host root, exhibit very active divisions in all planes (Plate 2, fig. 10; Plate 8, fig. 85), so that the secondary root often reveals a heterogeneous cortical tissue. The cortical cells away from the host root are large, rounded, and more or less spongy in character, while those facing the host root are much smaller and possess distinct nuclei and denser cytoplasm. In the latter cells, starch grains are not abundant, and this is perhaps due to their rapid consumption during cell divisions. Later, some of the cortical cells divide radially, so that rows of radially elongated cells are formed, which become the forerunners of the vascular bundles in the young developing tubercle (Plate 8, fig. 86).

THE HAUSTORIUM

How connection with the host root is effected in an *Aeginetia* seedling is described by Kusano.(29) He found that upon germination the seed sends out from its radicular end two or three large, hyaline, globular cells, which are highly turgescent, and each is provided with abundant cell sap. Their nuclei are large and conspicuous, and the cytoplasm radiates from them. Those globular cells increase in number generally up to fifteen, approximately, comprising the epidermal cells of the radicular end of the embryo, swelling to nearly four times their original diameter. Kusano claims it is improbable that multiplication of cells may be partly concerned in the increase in size. Each globular cell protrudes its external wall, which has first a conical and then a papillalike form. These outgrowths proceed further to form slender hairs, some of which grow to a length of about a millimeter. These hairs are either septate or even branched, and are rhizoidal in character. They usually grow straight and

radiate in all directions if undisturbed; if they come in contact with the host root, they seem to attach themselves firmly to it, and then coil or contract through their whole length, whereby the seedling is drawn closer to the host. Kusano was not able to determine with absolute accuracy how the hairs fix themselves on the host root. The hypodermal cells below the hair-tendril cells of the embryo form the tubercle, which penetrates the host root, and thus becomes organically connected with the host root by means of a haustorium.

In *Orobanche*(27) the radicular half of the embryo develops into a filamentous radicle, the plumular half remaining throughout in the endosperm acting as an absorbing agent. Parasitism here is effected by the root tip.

The seed of *Phelipaea ramosa,*(10) upon germination, sends out a long, filamentous, multicellular radicle devoid of root hairs, the end of which is enlarged. This radicle pushes itself through the endosperm, while the chalazal end of the embryo gives rise to the stem. The tip of the radicle penetrates the cortex of the host root. Vascular bundles of the root are developed, but no connection can be seen between its main bundle and the haustorium. The upper end of the haustorium enlarges and later sends out adventitious roots.

Massee(33) pointed out that the seed of *Lathraea squamaria* Linn. sends out a tap root upon germination, and this root gives off numerous branches, each furnished with minute hemispherical suckers or haustoria. The root forms short root hairs and these penetrate between the epidermal cells of the host, while the central vascular portion penetrates deeply until it reaches the pericycle of the host from where it absorbs nutriment.

How organic connection is made by *Melampyrum pratense* with its host has been fully described by Leclerc du Sablon.(30) The two-layered cortex of the root greatly elongates at the region facing the host root, and the cells there divide in various directions, forming a swelling; the epidermal cells, which were first isodiametric, send out lateral protuberances. One of the epidermal cells towards the host elongates tangentially at first, and then divides radially or anticlinally several times, some of its daughter cells actually elongating. These elongating cells form rootlike outgrowths, which penetrate the host root. The pericycle does not in any way remain inactive and its cells elongate and later divide periclinally at the region contiguous to the enlarged cortical region, simulating the formation of a

branch root; this forms the major portion of the haustorium. This activity of the pericycle presses down the endodermis so that it actually disappears at this region of the root. The piliferous layer may, in certain cases, exhibit very active radial divisions, the daughter cells of which elongate to form a compact mass of hairs. These hairs also penetrate the host roots. Hairs formed by the epidermal cells grow into the host much as the mycelia of a fungus penetrate its host, dissolving the host cells on their way by simple diastase reaction. These hairs form a "vascular system" with spiral thickenings, and differentiation of their reticulations proceeds until there is formed a continuous canal from the hairs to the central cylinder of the main root. A similar development of the haustorium has been described by this investigator for *Melampyrum cristatum, M. silvaticum,* and *M. nemorosum.* In *Tozzia alpina,* as well as in *Rhinanthus* (*Alectorolophus*) and *Pedicularis,* Leclerc du Sablon(30) believes the haustorial development is identical with that of *Melampyrum.* Barber(4, 5, 6) is of the opinion that the formation of haustoria in *Olax scandens* and *Santalum album* is similar to that given by Leclerc du Sablon(30) for Rhinanthaceæ (Scrophulariaceæ).

In *Christisonia bicolor* Gardn.(52) the external cells of the root at the point of contact divide in places, and the cells for some distance on either side become elongated radially, while they become filled with dense cytoplasmic content and exhibit conspicuous nuclei; at the same time cortical cells immediately below this layer divide rapidly in succession in several directions; a few divisions occur in those more deeply situated. As a result of those cell divisions in the initial stage of haustorial formation, the cortex bulges considerably. A few cells on either side of the point of contact grow into hairlike papillæ, which possess thick walls and dark brown contents with prominent nuclei. These grow towards the host root. The portion of the cortex at the point of contact at length, by repeated divisions in the cells, grows out as the haustorium, the cells in contact being much elongated and more or less contorted, with dense cytoplasm. Its origin is, therefore, exogenous, and no sieve tubes are present. Its development is quite different from that of *Rhinanthus* and *Cuscuta.*

In *Aeginetia indica* Linn. the writer believes entrance into the host root is effected by the pressure exerted by the enlarging epidermal and cortical cells of the tubercle facing the host root (Plate 2, fig. 13). The haustorium then penetrates the host

cortex through the endodermis into the stele of the sugar-cane root (Plate 2, fig. 15). The ground tissue of the haustorium is parenchymatous, and its cortex is continuous with that of the tubercle. The cells (Plate 2, fig. 12) that abut the vessels of the host root are variously shaped, and contain dense cytoplasm. These cells become somewhat tubular to rectangular upward in the haustorium. Some of the central cells of the haustorium may become reticulately thickened and form the conductive system connecting the parasite with the vascular bundles of the host root. Connection is made not only with the xylem vessels but also with the phloëm tissue of the host root, so that the parasite actually draws water and elaborated food from the host.

The haustorial bundle branches into two or more divergent bundles before passing into the central cylinder of the tubercle, and these bundles may oftentimes dip away into the cortex without exhibiting actual connection with vascular bundles of the main root. Worsdell(52) claims that in *Christisonia* these bundles act as storehouses for the spoils of the haustorium, and by traversing the enlarged cortical tissue in all directions aid greatly in distributing the nutriment throughout the tissues of the tubercle so formed, supplying the young lateral roots and scapes with an abundance of food.

THE SCAPE

General consideration.—The scape arises endogenously(28) from the tubercle. Under laboratory conditions, scapes are formed about two to three months after inoculation of the cane seedlings in sand. In the formation of scapes the tubercle (Plate 9, fig. 91, *B*) is the one organ responsible for their development, but in ratoon canes the writer has observed that scapes may arise directly from the main root of the parasite without first forming a tubercle (Plate 9, fig. 91, *A*).

Under field conditions the buñga usually flowers more or less simultaneously with the sugar cane or oftener ahead of it. Even after the canes are harvested, the buñga may continue to produce reproductive organs (Plate 9, fig. 90), perhaps to tide them over until the ratoon canes have started to grow again. Actually, however, the parasite starts to form scapes from its tubercles long before the flowering season of the sugar cane comes. Simultaneously with the development of the scapes and their emergence from the soil, the sugar-cane plants form a thick covering over the area that conceals the flower buds of

the parasite. When the canes are so tall that their basal leaves have dried up, a clearer view of the basal portion of the canes is obtainable, and at this time the buñga flowers are maturing. It is only at this stage of development that the buñga is actually recognized in the field, and by this time the damage to the canes has been done, and buñga-seed production is perhaps at its best. As the buñga is an ombrophyte, its aërial organs are less vigorous and may even degenerate when this parasite is growing under direct sunlight. Consequently it does better in the shade, a condition most favorable also to the growth of the Javan *Aeginetia saccharicola* Bakh., which was reported by Coert.(13)

The scape is colorless before its emergence from the surface of the ground, and forms its peculiar pigmentation on exposure to air. It is short, terete, somewhat rigid, atropurpureous, 1 to 5 centimeters, rarely up to 15 centimeters, long, and from 0.3 to 1 centimeter in diameter.

Origin.—The endogenous origin of the scape as reported by Kusano(28) is correct. A group of embryonic cells is differentiated deep in the cortex of the tubercle (Plate 8, fig. 87) and as these cells grow outward through the cortex, the parenchymatous cells behind them form vascular bundles to the scape. These embryonic cells, as they approach the periphery of the tubercle, cut off lateral protuberances (Plate 8, figs. 87 and 88), which form the scale leaves acting as protective covering to the growing point of the scape (Plate 2, fig. 14; Plate 8, fig. 89).

Anatomy of the main axis.—A transverse section of the central axis to the scape, taken at or near its attachment to the tubercle, reveals the presence of bicollateral vascular bundles arranged in a ring on a ground parenchyma filled with an abundance of starch grains (Plate 2, fig. 16; Plate 4, fig. 33). It is somewhat circular in outline, and is surrounded by a distinct epidermis of small, oblong to rectangular or squarish cells, the outer walls of which are somewhat papillate. In the sap of the epidermal cells is dissolved the pigment to the scape. Inclosed by this epidermis is a thin cortex of small or large, oblong to rounded, tubular, parenchymatous cells, which are loosely packed together, and each is provided with a copious supply of starch grains. These cortical cells are smaller near the epidermis and become progressively larger towards the

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stele. The endodermis, or starch sheath, and the pericycle are not differentiated in this organ, as is true of *Christisonia subacaulis* Gardn.(52)

The individual vascular bundle (Plate 2, fig. 16) is more or less rhomboid, and is inclosed by a bundle sheath consisting of three or four layers of sclerenchymatous cells. Surrounded by the sclerenchymatous bundle sheath is the phloëm, which consists of distinct companion cells, sieve tubes, and parenchyma. The interior and exterior phloëms have the same structure. The few tracheids, which occur in groups, are arranged in small broken rings and have thickened walls and reticulated thickenings. These surround a group of parenchyma at the center of the bundle. Separating the groups of tracheids and the phloëms is an inner and outer discontinuous cambiumlike tissue one to two layers thick.

The bicollateral bundles are separated from each other (Plate 2, fig. 16; Plate 4, fig. 33) by few to several layers of cells similar to those found in the cortex; these are filled with starch grains.

The pith is made up wholly of large, parenchymatous cells with a copious supply of starch grains and mostly rounded to isodiametric in transverse section, similar to those present in the cortex.

The number of vascular bundles of the main axis increases upward as a result of branching, and this is correlated with an increase in diameter. The epidermis and the cortex remain as before, while the pith is somewhat enlarged and possesses the same characteristic cell structure as described above. The bicollateral bundles are more numerous and lie closer together (Plate 3, fig. 17), forming at times an almost continuous ring owing to the fusion of their sclerenchymatous bundle sheaths. In the majority of these bundles the sclerenchymatous sheath actually invaginates radially into the bundle from its outer tangential side, thus forming a U-shaped bundle (Plate 3, fig. 17).

The individual bundle is also bicollateral (Plate 3, figs. 17 to 19). The tracheids are arranged in groups and separated by parenchyma. On the outer and inner tangential sides are the phloëm groups which consist of sieve tubes, companion cells, and parenchyma. Separating the tracheid groups and the phloëms are scattered cambiumlike cells.

Worsdell(52) observes the presence of a ground tissue of hexagonal to rounded cells filled with starch grains, and the vascular bundles are arranged in an irregular ring in the stem of *Christisonia.* These bundles lie side by side in groups, separated by wide spaces of ground tissue. The individual bundle is circular in outline and is concentric in *Christisonia neilgherrica* Gardn. In stems of *Aphyllon uniflorum* Gray,(44) as well as in *Epiphegus virginiana,*(14) bicollateral vascular bundles are present; these stems possess an abundance of starch grains, which pass into the soil with the decay of the plant.

The main axis is devoid of stomata and trichomes, and is entirely glabrous. In *Christisonia neilgherrica* Gardn. stomata are present, rising above the surface of the stem, while in *Ch. subacaulis* Gardn. and *Ch. bicolor* Gardn. stomata are entirely absent.(52) Cooke and Schively(14) attribute the withering of *Epiphegus virginiana* after several of them have attacked a host, to the presence of numerous stomata. In *Aeginetia indica* Linn. nonresistance to the desiccating effect of direct sunlight is due to the absence of a heavy protective coating on the surface of the scape.

At maturity of the fruits, the main axis of the scape decays and actually becomes separated from the tubercle that bears it. Decay of the main axis begins at its epidermis, and proceeds into the cortex and into the pith at times; only the skeleton of the vascular bundles is left to hold the scape erect. At a slight mechanical pressure this scape becomes automatically severed from the parent parasite, and thus helps in disseminating the seeds.

Scale leaves.—The main axis of the scape bears a few to several scale leaves, which are spirally arranged on it (Plate 3, fig. 20). Each of these scale leaves subtends at its axil a branch or pedicel, which carries at its apex a single flower (Plate 5, fig. 34). At maturity each scale leaf is more or less glabrous, somewhat erect at first, later becoming horizontal, oblong ovate, small, and acuminate, acute or even obtuse, its base more or less clasping the main axis. It is about 0.5 to 2 centimeters long, and 0.3 to 0.5 centimeter broad. Because of the elongation of the main axis above a scale leaf, the pedicel or branch subtended by the scale leaf is carried way up, so that at maturity the scale leaf is borne far away from the pedicel or branch that it subtends.

In transverse section the scale leaf is lunar in shape (Plate 3, fig. 20) and possesses distinct epidermal layers consisting of small, laterally compressed, rectangular cells on the dorsal or nether surface, and large, rounded to isodiametric cells with papillate outer tangential walls on the ventral or upper side (Plate 1, fig. 9). In these epidermal cells the pigment of the scale leaf is found. These epidermal cells are all elongated in surface view with their long axes parallel to the length of the scale leaf, their end walls being mostly set horizontally, although a few of them may be set obliquely. The mesophyll is occupied by loosely packed, parenchymatous cells, which are isodiametric; in this mesophyll are distributed the vascular bundles. These vascular bundles, which are poorly developed, lie near the ventral or upper side of the scale leaf. A single vascular bundle enters a single scale leaf, and this single bundle branches out several times as it traverses the whole length of the mesophyll of the scale leaf.

On the upper side of the scale leaf are often a few, well-developed stomata consisting of two very much elongated, bean-shaped, guard cells, with their long axes parallel to the length of the scale leaf. The first organ of the parasite to show signs of desiccation is the scale leaf, and this susceptibility to drying is due perhaps to the presence of few of those natural openings. On the scale leaves of *Aphyllon uniflorum* Gray (44) stomata are found on the undersurface, while in those of *Christisonia subacaulis* Gardn. (52) stomata and mucilage-secreting glands are found scattered on their ventral sides.

Stalk or pedicel.—Subtended by a scale leaf is a stalk or pedicel (Plate 3, fig. 20), which holds a single flower at its apex (Plate 5, fig. 34). It is more or less erect, terete, and thickened upward, glabrous, atropurpureous, 10 to 30 centimeters long, and 0.1 to 0.4 centimeter in diameter.

In transverse section the young pedicel shows the presence of distinct groups of procambial strands (Plate 3, fig. 21) arranged in a ring on a ground of parenchymatous tissue. The epidermis consists of radially elongated cells, in which is found the pigment, and these epidermal cells inclose a rather wide cortex of thin-walled cells. The cortical cells are rounded to oblong and larger than the epidermal cells. The pith cells are similar to those found in the cortex and this ground parenchyma is provided with an abundance of starch grains.

As the stalk or pedicel matures, its epidermal cells become tangentially flattened, and are rectangular or more or less elongated vertically. The cortex becomes proportionately smaller and thinner, and consists of several layers of large, rounded to isodiametric, parenchymatous cells in transverse section, between which are small intercellular spaces. These cortical cells contain starch grains and tend to become larger from the epidermis inward to the middle portion, and gradually become smaller again towards the stele. The endodermis is indistinct or perhaps absent.

The individual vascular bundles (Plate 4, fig. 29) are collateral, and arranged in a ring. The phloëm, which forms the major portion of a bundle, consists of distinct parenchyma, companion cells, and sieve tubes. Running radially through the phloëm are uniseriate or biseriate rows of hexagonal ray cells. The sieve tubes and companion cells occur in groups. The xylem, which lies towards the pith, is composed of groups of reticulated tracheids with thickened walls and separated by parenchyma. Between the tracheids are also found the hexagonal ray cells. The xylem and the phloëm are usually separated by distinct cambium consisting of one or two layers of cells occurring in patches.

The pith is occupied by large, rounded, parenchymatous cells rich in starch grains and intercellular spaces.

The mechanical tissues to the pedicel consist of the sclerified and lignified inner cortical cells (Plate 4, fig. 29), as well as the lignified groups of cells separating the individual bundles and the peripheral pith cells. All these lignified tissues contribute to the rigidity of the pedicel.

At maturity of the fruit, the pedicel turns black first at or near the point of its attachment to the capsule, and this blackening progresses downward to the main axis of the scape. The pith cells are resorbed, and at the time the pedicel is dry, the pith is hollow. With the decay of the pedicel the unused starch grains in the cortex pass into the soil.

Stomata are absent on the pedicel of *Aeginetia indica* Linn.; they are present in *Conopholis americana* (51) and *Aphyllon uniflorum* Gray. (44) In *Conopholis* there are two concentric rings of separate collateral vascular bundles, the respective phloëms of both rings facing each other.

The flower.—Each scape develops from one to a dozen flowers (Plate 5, fig. 34), each of which is long-pedicellate. Its calyx is ovoid, compressed, its base inflated, apex acute, more or less apiculate, coriaceous, glabrous, and very much shorter than the corolla. Externally it is purplish with longitudinal yellow stripes; internally it is white or pale yellow, becoming blackish purple upward on its dorsal side. It measures from 1.5 to 3 centimeters, rarely as much as 5 centimeters, in length and 1 to 1.5 centimeters in diameter. Inclosed by it is a colorless, mucilaginous liquid secreted by multicellular glandular hairs (Plate 5, figs. 38 and 39) on its inner surface.

Anatomically the calyx (Plate 3, fig. 22) has a distinct outer and an inner epidermal layer. The outer epidermal cells are much smaller than the inner, and their outer tangential walls are papillate. On surface view the outer epidermal cells are oblong to irregularly trapezoidal or nearly isodiametric with straight walls. The inner epidermal cells are much larger than those from its outer epidermis, more or less rectangular to oblong or even rounded in shape, their outer walls somewhat papillate, but almost always straight. On surface view these are identical with those of the outer epidermis of the calyx, but above the vascular bundles the epidermal cells are somewhat elongate. Both epidermal layers bear the pigment of the calyx. On the inner epidermis are borne, here and there, numerous glandular hairs, or trichomes (Plate 5, figs. 38 and 39), consisting of a uniseriate, a few- to several-celled stalk and a multicellular, glandular apex, the cells of which are often pigmented. In *Epiphegus virginiana*(14) the trichomes are on the outer portion of the calyx and absent from the inside, while in *Christisonia bicolor* Gardn.(52) the trichomes are borne inside. Stomata are absent from the calyx of *Aeginetia indica* Linn., but abundant on both surfaces of the calyx of *Christisonia neilgherrica* Gardn.(52) and *Aphyllon uniflorum* Gray.(44)

The mesophyll has a ground tissue of large, loosely packed, rounded to isodiametric, thin-walled cells with few to abundant starch grains in the inner half of the calyx. The vascular bundles are located near its inner epidermis.

The corolla is 2-lipped, tubular-campanulate (Plate 5, fig. 34), and its five lobes are more or less reniform, rotund or suborbicular, obscurely crenate, unequal or subequal, 0.25 to 1 centimeter long, and about 0.5 to 1 centimeter, rarely 1.75 centimeters, broad. It is twice, or even thrice, as long as the calyx,

curved at the insertion of the stamens, 2.5 to 5 centimeters long. At its basal portion it is more or less constricted above the ovary. Externally the corolla is pale purple, deepening near the calyx, and white at its base. Internally it is deep purple in the region around the pistil and at its mouth. It is thinner and more delicate than the calyx, and usually dries off easily.

This corolla possesses an outer layer of epidermal cells (Plate 3, fig. 23), which are rectangular, tangentially flattened, and with often papillate outer walls. The inner epidermal cells are much larger than the outer. From these epidermal cells of both inner and outer layers are developed numerous glandular trichomes (Plate 5, fig. 39) similar to those found on the calyx. Stomata are absent on the corolla of *Aeginetia indica* Linn., but present in *Aphyllon uniflorum* Gray.(44)

The mesophyll consists of loosely arranged cells provided with starch grains, leaving between them large air spaces. Vascular bundles, which lie nearer its inner epidermis, traverse the mesophyll.

The stamens are four in number (Plate 3, fig. 24), epipetalous and didymous (Plate 5, fig. 34), very similar to those found in *Christisonia.*(52) At maturity these are united at their anthers owing to the secretion of a thick mucilage by the glandular trichomes found on the filaments near their attachment to the connectives (Plate 3, fig. 26). The anthers are violaceous in color, and bilocular when young (Plate 3, fig. 24; Plate 5, fig. 41), each locule being more or less crescent-shaped, owing to the projections of the broad, conical band of sterile tissue from the connective. At maturity of the anther, however, the wall partition between the two loculi breaks away, so that the anther becomes unilocular. Each of the two posterior stamens has a peculiar swollen prolongation, or spur, from the connective, which is deflexed and equal in length to the anther, arising near the attachment of the filament. This spur (Plate 3, fig. 25) is somewhat oblong in transverse section, and is filled internally with a parenchymatous ground tissue delimited by a distinct epidermal layer. The parenchymatous ground tissue possesses large intercellular spaces, and is traversed by a single large central vascular bundle that never reaches its apex. The filaments are white, rather slender, and more or less curved. Each of the filaments is somewhat polygonal in transverse section (Plate 3, fig. 26) and consists of large, rounded, parenchymatous ground

tissue with large to small intercellular spaces and an abundance of starch grains. On the outer portion of the filament is a single layer of epidermal cells. On this epidermis are borne glandular hairs (Plate 5, fig. 39) similar to those formed on the calyx and the corolla, and these hairs secrete mucilage cementing the anthers together long before anthesis. The glandular hairs are mostly at or near the attachment of the filament to the connective of the anther. Traversing the ground parenchyma of the filament is a single vascular bundle.

The stigma is rather large (Plate 5, fig. 34), cordate-pileate, white to yellowish white, and 0.3 to 0.35 centimeter in diameter. It is covered with numerous hairlike processes, which are much elongated and somewhat pointed (Plate 4, fig. 32). Within these elongated cells, the cells are rather loose and contain an abundance of starch grains. On these expanded, elongated processes of the stigma, the microspores germinate (Plate 4, fig. 32).

The style is somewhat cylindrical, inflexed, glabrous, white, hollowed in the center (Plate 3, fig. 27), and from 1.5 to 2 centimeters long. It is covered by a distinct epidermis consisting of small, radially elongated, papillate cells, inclosing a ground parenchyma of loosely packed cells showing distinct air spaces, and provided with starch grains. Bordering on the central cavity are groups of elongated cells which are papillalike and swollen with mucilaginous secretions. These secretions are, perhaps, conducive to the growth of the male gametophyte. Two vascular bundles traverse the style throughout its length.

The ovary is ovoid (Plate 5, fig. 34), conical near the stylar end, cordate at the base, pale yellow, glabrous, 1 centimeter long, and 0.7 to 1 centimeter in diameter. It is bicarpelled (Plate 3, fig. 24; Plate 5, fig. 46), and unilocular throughout. Borne on the wall of the ovary are two opposite, lamellate placentas, their free lamellæ being irregular, deeply branched, and intensely plicate, becoming membranous at maturity of the fruit. These placentas extend into the ovarial cavity and lie through the whole length of the ovary. On the surface of the placentas are borne numerous anatropous megasporanges, which are extremely small. On the ground parenchymatous tissue of the ovary wall and the placentas is an abundant supply of starch grains.

The unilocular ovary with four placentas is also reported in *Christisonia bicolor* Gardn.,(52) *Aphyllon uniflorum* Gray,(44) and *Epiphegus virginiana*.(14) Of the four species of *Aeginetia* reported from the Netherland Indies by Bakhuizen van den

Brink,(3) *Aeginetia indica* Linn. has four placentas, the rest have only two.

Organography of the flower.—The development of the floral organs is acropetal and they arise as follows: Calyx, corolla, stamens, and pistil. The earliest stage the writer was able to obtain was when the primordium of the pedicel to the flower has emerged from the axil of the scale leaf (Plate 2, fig. 14; Plate 5, fig. 35; Plate 8, fig. 89). It appears as a hemispherical mass of meristematic cells, which elongates first, and at its terminus the flower is developed. The first floral organ to emerge from this floral primordium is the calyx, and this is followed by the corolla (Plate 5, fig. 36). Within the corolla, small mammillate protrusions emerge as the primordia of the stamens (Plate 5, fig. 37), and these are followed by the formation of the carpels on the apex of the floral primordium. The calyx has a definite growth, so that the corolla has to break its way through it long before anthesis (Plate 5, fig. 34).

MICROSPORANGE AND MICROSPORES

The anther shows two distinct lobes in transverse section (Plate 3, fig. 24; Plate 5, fig. 41), and with a slight prolongation on the opposite side of the attachment of the filament. Under each lobe, one or more rows of cells (Plate 5, fig. 42) situated on the third layer below the epidermis, differentiate as the sporogenous tissue. These cells are easily distinguished from the surrounding cells by the density of their cytoplasm and by their heavily stained, large nuclei. This sporogenous tissue forms a solid crescent-shaped band on each lobe (Plate 5, fig. 41) and is continuous through the whole length of the anther.

Of the parietal tissue, which is two-layered (Plate 5, fig. 42) at first, the layer directly in contact with the sporogenous tissue functions as the tapetum. These tapetal cells elongate radially and become binucleate or even trinucleate at the time the microspore mother cells are in synapsis. The increase in the number of nuclei of the tapetal cells results from the divisions of their nuclei.

The outer parietal layer of cells (Plate 5, fig. 42) may increase in thickness by a few periclinal divisions during the development of the anther (Plate 5, fig. 43). As the microspores are formed, this parietal tissue is actually destroyed or consumed, except the hypodermal layer which forms the endothecium in the mature anther (Plate 5, fig. 49).

The sporogenous tissue by subsequent divisions forms a mass of microspore mother cells (Plate 5, fig. 43). As the microspore mother cell enters synapsis (Plate 5, fig. 44), its cytoplasm usually shrinks away from its original wall, and proceeds to divide successively to form the tetrahedral tetrads (Plate 5, fig. 45), at which time the original wall of the mother cell has already disappeared. The tetrads are at first embedded in a special gelatinous coat (Plate 5, fig. 45), and as this coating eventually dissolves (Plate 5, fig. 47), the microspores are liberated. The young microspores then round off, and acquire their own coats. Long before dehiscence the single nucleus of the individual microspore undergoes division so that it becomes binucleate (Plate 5, fig. 48). Each microspore then possesses a large rounded and distinct vegetative nucleus, and a small, lenticular, rather densely stained generative nucleus. Successive division of microspore mother cells has also been reported in *Epiphegus virginiana.*(14) Among other parasites in which binucleate microspores have been reported are: *Viscum album,*(41, 42) *Rhopalocnemis phalloides* Jungh.,(32) *Rafflesia patma* Bl.,(19) and *Epiphegus virginiana.*(14) However, in *Rhopalocnemis phalloides* Jungh.(32) trinucleate microspores are sometimes present.

Gates(20) has observed that the wall of the microspore mother cell in *Lathraea* usually remains in contact throughout the whole process of meiosis until its final dissolution. It does not round off and separate from its sister cells completely. Instead, a special microspore mother cell wall, often of great thickness, develops inside the original wall, and this special wall may lie in contact with or be clearly detachable from, the mother wall. From this special wall wedge-shaped protrusions into the cytoplasm from four equidistant peripheral points become visible. After the formation of these wedges, active furrowing of the cytoplasm takes place, and the peripheral wedges are prolonged by passive deposition of wall materials and not by invagination. The prolongation of the peripheral wedges progresses towards the center. Simultaneously with this formation of wall from the special microspore mother wall, the original wall remains, and later dissolves, leaving the special mother wall exposed, which in turn dissolves liberating the four microspores. The writer was not able to follow this very closely in *Aeginetia,* but the material on hand seems to indicate that

the same process of wall formation probably takes place in this parasite.

Simultaneously with the destruction of the parietal tissue of each sporange, the cells separating the two adjacent microsporanges are also destroyed, so that the two microsporanges merge to form a single, large locule. At maturity of the anther only its epidermis and a single hypodermal cell layer, the endothecium, persist. The epidermis remains parenchymatous, while its endothecial cells become thick-walled and devoid of the rod-shaped thickenings that are often encountered in anthers of many angiosperms (Plate 5, fig. 49).

MEGASPORANGE AND MEGAGAMETOPHYTE

The megasporange appears as a small papilla formed by the activity of the cells of the placenta, a condition similar to that obtaining in *Christisonia neilgherrica* Gardn.(53) The epidermal cells of the placenta (Plate 6, fig. 50) contain dense cytoplasm and distinct nuclei, and are usually elongated vertically. These epidermal cells show active anticlinal divisions at various points, and this activity affords a good means of allowing space for the growth of the young megasporanges. In this small papilla (Plate 6, fig. 50) the hypodermal cell of the placenta enlarges and divides periclinally (Plate 6, fig. 51). Its daughter cells enlarge and also divide periclinally (Plate 6, figs. 52 to 54). Division usually takes place first in the lower daughter cell (Plate 6, fig. 52) and then in the upper cell (Plate 6, fig. 53), or the upper daughter cell may not divide at all and three basal cells in a row may arise from the lower daughter cell of the juvenile megasporange (Plate 6, fig. 54) by the formation of two periclinal walls. However, the ultimate product is a uniseriate row of four or more cells (Plate 6, fig. 55), and these cells are covered with an epidermis, which is continuous with that of the placenta. The terminal cell (Plate 6, figs. 54 and 55) in the row usually functions as the megaspore mother cell, while the basal cells constitute the cells to the funiculus.

As the megaspore mother cell elongates and enlarges, and by the time the young megasporange begins to show signs of unequal growth, or even later, an epidermal cell of the megasporange divides periclinally (Plate 6, fig. 54). Division of this epidermal cell is followed by those behind it, such that the nucellus and the single integument become differentiated (Plate 6,

figs. 56 and 57), the former remaining two-layered near the micropyle, and only one-layered farther down the chalaza of the megasporange. Eventually, the integument becomes one-layered in the mature megasporange.

As a result of a quicker growth of the cells on one side, the megasporange bends over towards the opposite side, its apex being at this time directed at an angle of about 45° to the surface of the placenta (Plate 6, fig. 56). By further growth the apex of the nucellus becomes at length directed perpendicularly to the surface of the placenta, and the megasporange assumes its mature anatropous position (Plate 6, fig. 57).

The development of a single archesporial cell in Orobanchaceæ seems to be the rule; an exception is found in *Christisonia neilgherrica* Gardn.,(53) where occasionally two archesporial cells may differentiate, only one of which functions. In other parasitic phanerogams so far studied, many exhibit a unicellular archesporium.(7, 17, 18, 19, 31) Of those parasitic plants developing an archesporium consisting of more than one cell, may be mentioned the following: *Loranthus sphaerocarpus*,(48) *Viscum articulatum* Burm.,(47) *Helosis guyanensis*,(12) *Balanophora elongata* Bl.,(49) *B. phalloides* Jungh.,(32) *Pedicularis foliosa* Linn., *Melampyrum silvaticum* Linn., and *Lathraea squamaria* Linn.(39)

As the anatropous condition of the megasporange is reached, the megaspore mother cell enters synapsis (Plate 6, fig. 56), and divides periclinally (Plate 6, fig. 57). By two successive divisions this megaspore mother cell gives rise to four megaspores in a row (Plate 6, fig. 58), of which the chalazal one becomes functional (Plate 6, fig. 59). The formation of four megaspores has also been noted in *Orobanche*(7) and *Christisonia neilgherrica* Gardn.,(53) of the Orobanchaceæ.

In other phanerogamic parasites there is a great variation in the number of megaspores formed. For example, two megaspores are formed in *Dendrophthora oxycedri*,(54) *Viscum album*,(24) and *Balanophora elongata* Bl.;(17) three megaspores in *Loranthus sphaerocarpus* Bl.,(48) *Arceuthobium oxycedri*,(23) and *Pedicularis verticillata* Linn.;(39) three to four megaspores in *Balanophora globosa* Jungh.,(31) *Rafflesia patma* Bl.,(18) and *Pedicularis verticillata* Linn.;(39) and four megaspores in *Rafflesia hasseltii* T. and P.,(19) *Cytinus hypocistis* Linn.,(7) *Brugmansia zippelii*,(19) *Euphrasia rostkviana* Hayne, *E. odontitis* Linn., *Alectorolophus hirsutus* All., *A. minor* (Ehrh.) Wimm.,

Pedicularis palustris Linn., *P. caespitosa* Sieb., *P. recutita* Linn., *P. tuberosa* Linn., *P. foliosa* Linn., *Melampyrum silvaticum* Linn., *M. pratense* Linn., *Tozzia alpina* Linn., and *Lathraea squamaria* Linn.(39)

In some phanerogamic parasites exhibiting extreme degeneration of their plant organs there is a tendency to shorten the stages involved in the development of their megagametophytes. The formation of primary parietal tissue, for example, from the archesporium, which functions directly as the megaspore mother cell, is almost always absent in Loranthaceæ,(24, 48, 54) Balanophoraceæ,(17, 31, 32) Rafflesiaceæ(7, 18, 19) Scrophulariaceæ,(39) and Orobanchaceæ;(53) in *Arceuthobium oxycedri*(23) and *Balanophora elongata* Bl.(49) the archesporium forms a primary parietal cell. In fact, in some of these parasitic plants the archesporium may even give rise to the embryo sac directly, as in *Lilium;*(15) this is true also of *Helosis guayanensis,*(12) *Rhopalocnemis phalloides* Jungh.,(32) *Balanophora elongata* Bl.,(17, 49, 50) and *Epiphegus virginiana.*(14)

Of the four megaspores formed in *Aeginetia indica* Linn., the chalazal one becomes functional (Plate 6, fig. 59). Degeneration of the three micropylar megaspores does not follow a definite course. It may set in first at the middle megaspores (Plate 6, fig. 58), and then by the micropylar megaspore; or degeneration may start from the latter and proceed upward to the chalaza (Plate 6, fig. 59). At all events, only one of the four remains, and this is usually the uppermost, or chalazal megaspore.

The functional megaspore then enlarges and becomes much vacuolated. Its nucleus starts to divide quite early (Plate 6, fig. 60), and the daughter nuclei migrate to the opposite poles of the enlarged embryo sac, owing, perhaps, to the formation of a large central vacuole (Plate 6, fig. 61). Here the two daughter nuclei divide, and four nuclei (Plate 6, fig. 62) are formed. Another division of these four nuclei completes the normal octonucleate embryo sac often encountered among angiosperms (Plate 6, fig. 63). In Orobanchaceæ similar development of the embryo sac has been reported in *Orobanche* sp.(7) and *Christisonia neilgherrica* Gardn.,(53) and in *Phelipaea coerulea*(7) and *Lathraea squamaria* Linn.,(39) of the Scrophulariaceæ.

The mature embryo sac (Plate 6, fig. 63) is rather long and bottle-shaped, with its largest portion directed towards the mi-

cropyle and the other end often reaching the single-layered integument at the chalazal region of the megasporange. At the micropylar region is located the egg apparatus, which consists of two synergids and a megagamete. The synergid is elongated, more or less pyriform, and possesses a large terminal and a small basal vacuole. It has a distinct nucleus embedded in a rather dense cytoplasm situated near its base. In *Aeginetia*, as well as in other phanerogamic parasites, the "filiform apparatus" of the synergid is absent; in *Santalum album*(38, 45) and *Viscum album*,(43) however, this structure is present. The synergid is ephemeral in character, and seldom persists long (Plate 6, fig. 64; Plate 7, fig. 67) in the embryo sac. It usually shows signs of degeneration at the time the primary endosperm nucleus is dividing (Plate 6, fig. 65) or even earlier (Plate 6, fig. 64; Plate 7, fig. 67). The megagamete is a little larger than either of the synergids, and lies between them. It has a larger basal vacuole (Plate 7, fig. 67) and a larger nucleus embedded in a dense peripheral cytoplasm at its apex.

The polar nuclei (Plate 6, fig. 63) usually lie just above the egg apparatus and between the synergids or above the megagamete. They have large, distinct nucleoli and dense nucleoplasm. Soon these two polar nuclei fuse and a much larger fusion-nucleus results (Plate 6, fig. 64; Plate 7, fig. 67). This fusion-nucleus lies dormant for a long while above the egg apparatus, and it may be oblong, rounded, or oval, exhibiting prominent nucleoli and distinctly dense nucleoplasm.

The antipodals (Plate 6, fig. 63) are situated at the extreme chalazal end of the sac in a socketlike projection, which nearly touches the integument. These antipodals are somewhat persistent and may be arranged in a row (Plate 6, fig. 63; Plate 7, fig. 69) or the upper two may lie side by side below which is the third antipodal (Plate 7, figs. 67 and 70). In rare cases these antipodals may early show signs of degeneration (Plate 6, fig. 63), but usually they persist long after endosperm formation has been under way (Plate 7, figs. 69 and 70). Their cytoplasm is not dense compared with that in the egg apparatus, and their nuclei are much vacuolated and poor in nuclear content. In *Phelipaea coerulea* and *Orobanche* sp.(7) the antipodal cells are ephemeral in nature, while those found in *Lathraea squamaria* Linn.(7) are somewhat persistent, although not as persistent as those in *Aeginetia indica* Linn.

POLLINATION

Being ombrophytic in habit, this parasite flourishes in the thick cane plantation. Floral maturation usually takes place at the time the canes begin to flower or even earlier, at which time the sugar-cane plants have formed an impenetrable or impassable cover around the buñga plants in the fields. It will also be noted that the flowers of this root parasite are never held high from the surface of the ground. Under the conditions given above, the flowers of this parasite are seldom accessible to pollinating insects, except perhaps ants. The chance for insect pollination decreases as the distance from the edge of the cane field is increased, and vice versa. Insect pollination probably does take place, as it cannot be very well eliminated completely, but it may be considered as very insignificant, judging by the results of an examination of flowers at various stages of development.

Long before anthesis, the filaments of the stamens are rather short, and the stigma is held very high. Simultaneously with the maturation of the flowers and usually just before anthesis, these filaments elongate further, and actually push their anthers clear to the stigma (Plate 5, fig. 34), brushing the microspores against it. It will also be noted that dehiscence of the microspores usually takes place long before anthesis, so that if the stigma is examined at the time the corolla has just opened, an abundance of germinating microspores will be seen on the stigma (Plate 4, fig. 32). Microspores that fail to lodge on the stigma may fall on the corolla tube, where they may germinate (Plate 4, fig. 31) on account of the moisture present with the mucilaginous secretions within the corolla tube.

Autogamy is, in the writer's opinion, the most potent factor in the pollination of this parasite; insects play only a minor rôle in the transfer of the microspores from the anthers to the stigma of the same or different flowers. In *Orobanche*(25) the flowers are homogamous, rarely protogynous, bee-pollinated, and sometimes devoid of nectar. Usually the stigmas are held high, but later the stamens grow to the same level with the stigmas and easily pollinate them, a condition which obtains in the buñga flowers.

THE FRUIT

Description.—The fruit of the buñga is a globose or ovoid capsule, which is light yellow when immature, turning ashy gray

or even jet-black at maturity. Its apiculate style is persistent and the whole fruit may be from 1.5 to 2 centimeters long and from 1 to 1.25 centimeters in diameter. When fully mature, it is brittle, and its pericarp easily breaks off, exposing its lamellate placentas on which are borne the yellowish, minute, rather powdery seeds.

Development.—Soon after fertilization the ovary enlarges and the corolla withers. The calyx and the corolla remain as a persistent envelope to the enlarging ovary within them. Of the pistil, the stigma is the first to show signs of darkening, and as the fruit enlarges this darkening proceeds downward to the style. The stigma usually falls off early, while the basal portion of the style together with the enlarging ovary form the major portion of the capsule, the calyx and corolla always remaining as a persistent envelope. At maturity of the capsule, the corolla and the calyx as well as the capsule become dry. The corolla and the calyx break off easily at a slight mechanical pressure from without, and this is true also of the pericarp, so the seeds are easily exposed. Dissemination of the seeds is made more perfect by the detachment of the scape from the mother parasite, and this is effected by the disintegration of the epidermal and cortical cells of the main axis of the scape at the region nearest the ground during drying. This breaking or separation is often hastened by the attacks of termites, which are often abundant in cane fields.

The ovary wall of the pistil is at first very thin, and consists mostly of thin parenchymatous ground tissue delimited by distinct epidermal layers and provided with an abundance of starch grains. After fertilization and simultaneously with the maturation of the capsule, its pericarp becomes highly differentiated into two distinct regions. The cells of the outer half of the pericarp (Plate 5, fig. 40) remain parenchymatous. Later, the starch grains found in them disappear, and their walls become mucilaginous and ultimately disintegrate. On the other hand, the inner half of the pericarp possesses cells that become thick-walled and are highly lignified. This inner lignified half of the pericarp persists as the covering to the mature capsule. The mucilaginous character of the young capsule is partly due to the outer half of its pericarp and partly to the presence of the mucilage secreted by the glandular hairs on the inner surface of the corolla. At maturity of the capsule the mucilage around it gets

dry and the lignified inner tissue of the pericarp as well as the calyx and the corolla act as a protective wall to the fruit.

THE SEED

Description.—The small, yellowish, albuminous seed, which is beautifully illustrated macroscopically by Kusano,(28) is irregularly subglobose and is produced in abundance. Its testa consists of a layer of large, often yellowish cells with conspicuous reticulate thickenings. The cells of the testa are somewhat isodiametric, much more developed at the chalazal end as well as on the sides of the seed, but poorly developed in the micropylar region (Plate 7, fig. 82). Inclosed by the single-layered testa is the endosperm, consisting of large isodiametric cells filled with starch grains and oil. If the seeds are immersed in concentrated chloral hydrate overnight and then pressed between a cover glass and a glass slide with a drop of Sudan III, numerous red fat globules will be seen oozing from the seeds. The cellulose inner and radial walls of the endosperm are thin, while their outer tangential walls are coated with a heavy, rather thin, cutinized layer, which is hardly soluble in concentrated sulphuric acid. Inclosed by this endosperm is a small, oblong or rounded embryo, consisting of one or often two rows of cells surrounded by a distinct epidermis. The cells of the embryo are also isodiametric and parenchymatous, and in them are stored starch grains and oil. This embryo is simple in that it possesses no distinct plumule, radicle, or cotyledons. Its narrow end is directed towards the micropylar end of the seed. Kusano(29) also observed similar peculiarities of the seeds after placing them for some time in concentrated chloral hydrate and examining them in toto.

Among numerous species of Orobanchaceæ, Caspary(10) has observed that the mature seeds of *Orobanche cruenta* Bert., *O. procera* Koch., *O. pruinosa* Lapeyr., *O. epithymum* DC., *O. galli* Duby, *O. rubens* Willd., *O. lucorum* A. Br., *O. minor* Sutt., *O. amethystea* Thuill., *O. cumana* Wall., *Phelipaea coerulea* C. A. M., *P. arenaria* Walp., and *P. ramosa* C. A. M. are all egg-shaped, with one-layered testæ from the chalazal end to the middle and three- to four-layered ones on the micropylar end. *Orobanche* has porous walls on the testa, the pores being numerous, small, and rounded in *Orobanche cruenta, procera, pruinosa, epithymum, galli, rubens, lucorum, minor, amethystea,* and *cumana.* In *Phelipaea* the thickenings of the walls of the testa

are reticulate, similar to those obtaining in *Aeginetia indica* Linn. Of the thirteen species examined by this investigator, the endosperm is egg-shaped and consists of from nineteen to twenty-one cells in longitudinal section, and these are filled with oil globules. At the micropylar region about three-eighths of its length is occupied by the embryo, which is ovate-elliptic and consists of thirteen to fifteen cells in longitudinal section, and is four to five cells wide; all the cells contain oil. The embryo is devoid of radicle, cotyledons, and other accessory organs.

The seeds of the buñga are produced in abundance, but many of them show the absence of embryos and are, therefore, sterile. The seeds also exhibit variations in size, and the sterile ones are usually smaller than the fertile plump seeds. In ovaries where numerous megasporanges are formed, it is to be expected that not all of these would be fertilized, and this fact should be kept in mind in considering the development of sterile seeds. Several other factors known to cause sterility in seeds have not been ascertained, but it is sufficient to know that a single seed is enough to cause trouble in a hill of canes.

Endosperm.—The endosperm of this parasite is of the cellular type. Among the Orobanchaceæ a type of endosperm similar to the one reported here for the buñga has been described in *Phelipaea coerulea* and *Orobanche* sp.,(7) *O. hederae,*(40) *Christisonia neilgherrica* Gardn., and *Ch. subacaulis* Gardn.,(53) and perhaps *Orobanche cumana* and *O. ramosa.*(40) *Cuscuta*(15) and *Rafflesia patma* Bl.(19) show a nuclear type of endosperm, a deviation from the great majority of the parasitic phanerogams so far studied. In *Helosis guyanensis*(12) the single polar nucleus gives rise to the pseudoendosperm.

The primary endosperm nucleus very early divides (Plate 6, fig. 65) horizontally, and cytokinesis takes place between the two daughter nuclei (Plate 6, fig. 66). One of the daughter nuclei migrates into the small, cylindrical chalazal prolongation of the embryo sac, where it remains dormant (Plate 7, figs. 69 and 70). The lower daughter nucleus remains at the vicinity of the zygote, and this nucleus gives rise to the cellular endosperm found in the mature seed.

The first division of the nucleus of the lower endosperm cell seems to be vertical, and by repeated horizontal walls (Plate 7, fig. 68) vertical rows of endosperm cells result (Plate 7, figs. 69 and 70). During the development of this cellular endosperm, the embryo sac enlarges considerably at its micropylar end

where the endosperm remains one-layered (Plate 7, fig. 81), and widens rapidly upward where several layers of endosperm cells are produced (Plate 7, figs. 79 and 80). The development of the cellular endosperm from the lower endosperm cell pushes the upper endosperm cell (Plate 7, figs. 69 and 70), clear to the persistent antipodal cells at the chalazal end of the seed. This upper chalazal endosperm cell (Plate 7, fig. 70) may be homologous with the chalazal haustorium often encountered in other species of the Orobanchaceæ.(7)

The micropylar cells of the cellular endosperm elongate considerably and form haustoriumlike processes on the sides of the zygote (Plate 7, fig. 70). It is to be noted that although these micropylar endosperm cells have elongated longitudinally, they do not possess thick cytoplasm and distinctly amœboid nuclei, so constant a feature in haustorial cells reported in many species of the Orobanchaceæ. They seem to be degenerated haustorial cells (Plate 7, fig. 81), becoming nonfunctional in the species under discussion. Vertical divisions take place mostly among the endosperm cells (Plate 7, figs. 78 to 80) above these elongated, micropylar, haustorial cells, so that the endosperm becomes club-shaped in appearance, with its small, elongated, tapering end directed towards the micropyle, and its enlarged portion towards the chalaza. Of the endosperm cells thus formed in the developing seed, the peripheral ones are the largest, and are persistent (Plate 7, figs. 79 and 80) in the mature seed (Plate 7, fig. 82). Starch and oil are abundant in these endosperm cells.

Bernard(7) has observed that the primary endosperm nucleus in *Lathraea squamaria* Linn. divides into two, a wall separating the primary endosperm cell into two equal parts, the chalazal cell nucleus dividing and the cell enlarging so that it becomes binucleate. The micropylar cell forms the cellular endosperm, its micropylar cells becoming elongated and considerably enlarged with large nuclei. The enlarged binucleate chalazal endosperm cell elongates into the chalazal nucellus and funiculus, and possesses dense cytoplasm around its nuclei. In *Orobanche* and *Phelipaea* the chalazal daughter endosperm cell elongates in the direction of the funiculus and forms a conducting element, typical and homologous with that found in *Lathraea*. The superior endosperm cell becomes cellular.

As the buñga seed matures, the embryo gradually absorbs the endosperm tissue so that nothing of this cellular endosperm remains except its outermost, peripheral layer (Plate 7, fig. 82).

Embryo.—The zygote does not undergo division soon after fertilization (Plate 6, figs. 65 and 66; Plate 7, figs. 67 and 68), but remains dormant until after endosperm formation has long been underway (Plate 7, fig. 70). Soon after the cellular endosperm has been formed from the lower endosperm cell, the zygote elongates considerably, pushing itself between the endosperm cells (Plate 7, fig. 70). The zygote then seems to have undergone several transverse divisions (Plate 7, fig. 81), but the writer was not able to follow very closely the sequence of division of the zygote as the material on hand was very scant. It seems probable that the apical cell gives rise to the proembryo (Plate 7, fig. 71), while the basal cell forms the suspensor, which degenerates quite early (Plate 7, figs. 72 to 78). Division of the cells of the zygote is perhaps variable. However, a globose embryo devoid of cotyledons, radicle, and plumule, even of their rudiments, is developed in the mature seed (Plate 7, fig. 82).

Nucellus.—The nucellus of the megasporange undergoes enlargement soon after fertilization. Its cells are isodiametric, vacuolated, and filled with an abundance of starch grains, and their nuclei are small. During later development of the seed the stored starch grains in the nucellus disappear and are absorbed by the developing endosperm within. The enlarging endosperm then presses the nucellar cells against the massive testa, and this nucellus disappears in the mature seed.

Coat or testa.—Before fertilization the single integument has two rows of cells near the micropylar end of the nucellus (Plate 6, figs. 56 and 57) and only a single layer at the chalaza. Its outer layer of cells is continuous with the epidermis of the funiculus and placenta. As the seed approaches maturity, this coat becomes one-layered throughout. These cells of the coat at first form one of the tissues utilized for the storage of starch by the developing young seed, but after the endosperm is fully developed, this function is relegated to it, and starch grains disappear from the seed coat.

Long before maturity of the seed the single-layered testa becomes lignified, and its cells develop the characteristic reticulate thickenings on their walls. This beautiful and thick reticulation of the cells of the single-layered coat of the seed of this parasite is carefully illustrated by Kusano.(28) These lignified and reticulated testa cells render the seed hard to section with the microtome. In other words, the mature seed is protected externally by the lignified and reticulated cells of the seed coat,

or testa, and internally by the cutinized layer surrounding the tangential walls of the endosperm. Neither the seed coat nor the endosperm is well developed at the micropylar end of the seed, the former being sometimes absent or feebly developed, while the latter possesses no distinct cutinized layer on the outer walls of its cells.

SUMMARY

The anatomy and morphology of the vegetative and the reproductive organs of *Aeginetia indica* Linn., an important orobanchaceous root parasite on the sugar-cane plant in the Philippines, are herein reported.

An important factor to be considered as influencing its whole vegetative structure is its parasitism, and this finds expression in the retrogressive direction so as to suit the changed habit and conditions of the life of this parasite. Chief among its peculiarities, which may be taken as the outcome of its parasitic life, are (*a*) the branching and anastomosing root system; (*b*) the rhizomelike character of the roots, which are devoid of root hairs and root caps; (*c*) the formation of tubercles from which haustoria, young lateral roots, and scapes are produced—these tubercles serve as storehouses for the nutrition of the plant; (*d*) the modified anatomical structure of the cylinder of the root and scapes in which the xylem has become reduced and the phloëm correspondingly developed; (*e*) the correlation of the reduction of its conducting system with the absence of foliar leaves replaced by scales; (*f*) the complete absence of chloropyll; and (*g*) its great power of storing large amounts of starch in all its aërial as well as underground organs, which often pass out into the soil at the death of the plant.

The anatomical structure of the root does not preclude the possibility of water absorption taking place from the soil.

The root and the scape have endogenous origin, and the writer confirmed the findings of Kusano.(28) On ratoon canes secondary roots may directly form scapes or reproductive organs laterally or terminally, due perhaps to the stimulating action of the fire after the canes are harvested.

The aërial organs, except the scale leaves, are devoid of natural openings or stomata. The absence of natural covering to help prevent rapid loss of water from its organs is evident; this condition is responsible for its becoming an ombrophyte, and its resulting inability to withstand extreme exposure to the sun.

The development of its microspores is normal, and in all probability these microspores become separated by active furrowing of the cytoplasm through the formation of wedges derived from a special wall of the microspores similar to that obtaining in *Lathraea*.(20) The mature microspore is binucleate.

The megasporange arises as a papilla from the placenta, and very early becomes anatropous. It is unitegumentary, and a single apical and terminal megaspore mother cell is differentiated on its nucellus. The mother cell develops normally into a conventional seven-celled megagametophyte.

Pollination is largely autogamous, although insects may play a limited rôle in the transfer of its microspores from the anthers to the stigma of the same or different flowers.

The fruit is a dry capsule, containing numerous minute, yellowish, albuminous seeds. Its endosperm is of the cellular type, exhibiting vestigial formation of haustorial cells. The seed coat consists of one-layered, lignified, reticulately sculptured cells, while its embryo is composed of a globose, few-celled structure, devoid of cotyledons, radicle, and plumule. Covering the endosperm is a highly cutinized layer.

From the foregoing anatomical and morphological features of the buñga the following generalizations may be drawn: (*a*) Infestation of canes must be attributed largely to seeds left by previous buñga crops, but other avenues of infection may be found; (*b*) the high drying power of its organs is due to the absence of any natural covering designed to limit the escape of moisture once it is exposed to air; (*c*) the darkening of the parasite on exposure to air is due to the presence of tannin; (*d*) the seed is protected and is provided with an abundance of stored food (mainly starch and oil) in its endosperm and in its embryo, hence a very specialized form of attack has to be adopted to eradicate the parasite; (*e*) ratooning canes infested with the parasite is very favorable to the perennial growth of buñga; and (*f*) the effort to eradicate it must be centered on preventing seedage and the germination of the seeds left by previous buñga crops.

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ILLUSTRATIONS

Plate 1. Aeginetia indica Linnæus

Fig. 1. Transverse section of a young root; *co*, cortex; *ep*, epidermis; *p ph*, primary phloëm; × 240.

2. Transverse section of the central cylinder of an older root showing differentiation of the triarch primary bundles; *cc*, companion cell; *px*, primary xylem; *si t*, sieve tube; *co*, cortex; × 156.
3. Portion of a transverse section of a primary tubercle with a young primary root cut longitudinally, emerging from the former; *co*, cortex of the tubercle; × 156.
4. Portion of a vascular bundle from a transverse section of a mature root (taken from fig. 7); *ca c*, cambial cell; *px*, primary xylem; *scl r*, sclerenchymatous ring; *si t*, sieve tube; *tr*, tracheid; × 156.
5. Diagram of a section of a primary tubercle showing the cortex (*co*), central cylinder or stele (*ste*), primary root primordia (*pr*), and vascular bundles (*vb*); × 18.
6. Diagram to show relationship between the host root (*hr*) and the parasite; *co*, cortex of tubercle; *ste*, stele of tubercle; *h*, haustorium; × 18.
7. Diagram of a transverse section of a mature root; *co*, cortex; *ep*, epidermis; *px*, primary xylem; *scl r*, sclerenchymatous ring; *s ph*, secondary phloëm; *sx*, secondary xylem; × 18.
8. Embryogenic cells of a primary root primordium (shaded cells); *co*, cortex of tubercle; × 156.
9. Portion of a transverse section of the scale leaf; *l ep*, lower epidermis; *u ep*, upper epidermis; *vb*, vascular bundle; × 74.

Plate 2. Aeginetia indica Linnæus

Fig. 10. Transverse section of a secondary root showing early formation of secondary tubercle; *co*, cortex; *ep*, epidermis; *p ph*, primary phloëm; *px*, primary xylem; × 38.

11. Portion of a transverse section of a young primary tubercle showing vascular bundles cut transversely; × 156.
12. Longitudinal section of a haustorium (taken from Plate 1, fig. 6); *co*, cortex of tubercle; *en*, endodermis of host root; *tr*, tracheid to the haustorium; *xy*, xylem vessel of the host root; × 156.
13. Showing epidermal cells of the haustorium in contact with the cortical cells of the host root; *ep*, epidermal cells of the haustorium; *hr*, host root; × 156.

FIG. 14. Diagram of a transverse section of a tubercle showing a scape arising from it; *co*, cortex; *ep*, epidermis; *fp*, floral primordium; *sl*, scale leaves; *tub*, tubercle; × 18.

15. Diagram of a transverse section of the host root with a tubercle attached to it; *co*, cortex; *tub*, tubercle; *h*, haustorium; *hr*, host root; *ste*, stele of the host root; × 18.

16. Portion of a transverse section of the main axis of the scape showing a single vascular bundle; *co*, cortex; *bs*, bundle sheath; *ep*, epidermis; *ph*, phloëm; *pi*, pith; *tr*, tracheids; × 156.

PLATE 3. AEGINETIA INDICA LINNÆUS

FIG. 17. Diagram of a portion of a transverse section of the main axis of the scape far from the tubercle showing positions of the vascular bundles; *co*, cortex; *ep*, epidermis; *bs*, bundle sheath; *vb*, vascular bundle; × 18.

18. Portion of a single vascular bundle taken at *A* from fig. 17; *si t*, sieve tube; *tr*, tracheid; × 156.

19. Portion of a single vascular bundle taken at *B* from fig. 17; *si t*, sieve tube; *tr*, tracheid; × 156.

20. A diagram of a transverse section of the scape near its apex to show positions of the scale leaves and the pedicels; *m ax*, main axis; *ped*, pedicel; *sl*, scale leaves; × 18.

21. Diagram of a transverse section of a young pedicel showing positions of procambial strands (*ps*); *co*, cortex; *ep*, epidermis; × 18.

22. Portion of a transverse section of the calyx; *i ep*, inner epidermis; *vb*, vascular bundle; × 156.

23. Portion of a transverse section of the corolla; *i ep*, inner epidermis; *o ep*, outer epidermis; *vb*, vascular bundle; × 156.

24. Diagram of a transverse section of a young flower showing the relative positions of its parts; *ca*, calyx; *cor*, corolla; *l*, locule; *ov*, ovary; *p*, placenta; *st*, stamen; × 18.

25. Diagram of a transverse section of the spur of the stamen; *ep*, epidermis; *vb*, vascular bundle; × 18.

26. Diagram of a transverse section of a filament; *ep*, epidermis; *gh*, glandular hairs; *vb*, vascular bundle; × 18.

27. Diagram of a transverse section of the style; *ep*, epidermis; *mc*, mucilage cells; *ho*, hollow; *vb*, vascular bundle; × 18.

PLATE 4. AEGINETIA INDICA LINNÆUS

FIG. 28. Portion of a transverse section of an old root; *co*, cortex; *ph*, phloëm; *px*, primary xylem; *sx*, secondary xylem; *scl r*, sclerenchymatous ring; × 93.

29. A portion of a transverse section of a mature pedicel; *co*, cortex; *ph*, phloëm; *x*, xylem; *pi*, pith; × 93.

30. Longitudinal section of a root showing its apex; × 93.

31. Showing germinating microspores on the inner surface of the corolla tube; × 93.

32. Portion of a longitudinal section of the stigma showing microspores germinating on its papillate cells; × 93.

FIG. 33. A portion of a transverse section of the main axis of the scape near its attachment to the tubercle; *co*, cortex; *vb*, vascular bundle; *pi*, pith; × 62.

PLATE 5. AEGINETIA INDICA LINNÆUS

FIG. 34. A sketch of a mature flower with half of its calyx and corolla removed so as to expose its other organs; *ca*, calyx; *cor t*, corolla tube; *ov*, ovary; *ped*, pedicel; *st*, stamen; *sti*, stigma; *sty*, style; × 0.66.

35. A diagram of a longitudinal section of a young scape showing scale leaves (*sl*) at the axils of which arise the floral primordium (*fp*); × 18.

36. Longitudinal section of a young floral primordium showing calyx (*ca*) and beginnings of the petals (*pe*); × 18.

37. An older flower showing calyx (*ca*), petals (*pe*), and stamens already differentiated (*st*); × 18.

38. Showing young hairs from the inner epidermal cells of the calyx; × 360.

39. Mature glandular hairs from the inner epidermis of the calyx; × 360.

40. Portion of transverse section of the ovary wall, or pericarp, of a nearly mature capsule showing its lignified inner half and a disintegrating, mucilaginous outer half; × 66.

41. A diagram of a transverse section of an anterior anther; *sp t*, sporogenous tissue; *vb*, vascular bundle; × 38.

42. Showing the sporogenous tissue (*sp t*) and tapetum (*t*) with the parietal tissue (*pt*) (taken from fig. 41); *ep*, epidermis; × 360.

43. Portion of a longitudinal section of an older anther showing the mass of microspore mother cells (*mi mc*), tapetum (*t*), and thin parietal tissue (*pt*); *ep*, epidermis; × 360.

44. Microspore mother cell in open spireme; × 660.

45. Tetrads still in a special mucilaginous coat; microspore mother cell wall already gone; × 660.

46. Transverse section of the ovary showing the four placentas (*p*); *l*, locule; × 18.

47. Tetrads without special mucilaginous coat; × 660.

48. Microspore just before dehiscence showing a large, rounded pollen tube nucleus (*ptn*), or vegetative nucleus, and a lenticular generative nucleus (*gn*); × 660.

49. Portion of a longitudinal section of a mature anther showing epidermis (*ep*), endothecial layer (*endt*), and remains of the parietal tissue (*pt*); note the size of the microspores (*mi*); × 240.

PLATE 6. AEGINETIA INDICA LINNÆUS

FIG. 50. Showing enlargement of a hypodermal cell of the placenta and anticlinical division of its epidermal cell (*ep*); × 360.

51. First anticlinal division of a hypodermal cell of the placenta; × 360.

FIG. 52. Periclinal division of the lower daughter nucleus of the placental hypodermal cell; × 360.
53. Upper daughter cell dividing; × 360.
54. Young megasporange with an elongated, terminal megaspore mother cell (*mmc*); three lower cells arising from the lower daughter cell of the hypodermal initial; note the beginnings of the integument (*in*); × 360.
55. An older megasporange showing the megaspore mother cell; note unilateral growth; × 360.
56. A megasporange showing its terminal megaspore mother cell in open spireme; integument (*in*) fully differentiated as well as the nucellus; *mic*, micropyle; *f*, funiculus; × 360.
57. A still older megasporange with megaspore mother cell in metaphase stage (heterotypic); *in*, integument; *f*, funiculus; *n*, nucellus; × 360.
58. Tetrads; two middle megaspores showing degeneration, chalazal one enlarging; × 360.
59. Showing chalazal megaspore enlarged; three micropylar megaspores degenerated; × 360.
60. First division of the nucleus of the functional megaspore; × 660.
61. Binucleate embryo sac showing polarity; × 660.
62. Quadrinucleate embryo sac; × 660.
63. Mature embryo sac showing contents; antipodals (*an*) showing early degeneration; polar nuclei (*pn*) still unfused near the egg apparatus; *me*, megagamete; *sy*, synergid; × 660.
64. Showing early degeneration of the synergid (*sy*); *fn*, fusion nucleus; *me*, megagamete; × 660.
65. Showing the first division of the primary endosperm nucleus and degeneration of the synergid (*sy*); zygote (*zy*) dormant; × 660.
66. Daughter cells from the first division of the primary endosperm cell; zygote (*zy*) still undivided and synergid (*sy*) degenerating; *l end c*, lower endosperm cell; *u end c*, upper endosperm cell; × 660.

PLATE 7. AEGINETIA INDICA LINNÆUS

FIG. 67. Embryo sac showing degenerated synergid (*sy*) and antipodals (*an*); *fn*, fusion nucleus; *me*, megagamete; × 660.
68. Showing the second division of the daughter endosperm nuclei; wall not cut across; *zy*, zygote; *sy*, synergid; × 660.
69. Chalazal portion of the endosperm showing antipodals (*an*) and the upper endosperm cell (*u end c*); × 660.
70. Embryo sac with cellular endosperm, micropylar cells of which have enlarged and elongated; upper endosperm cell (*u end c*) remaining inactive and much elongated; antipodal nuclei (*an*) persisting and zygote (*zy*) elongated considerably; × 660.

FIGS. 71 to 78. Proembryos with degenerated suspensors (*sus*); × 660.
79 and 80. Transverse sections of the endosperm (*end*) and embryo (*em*); × 660.

FIG. 81. Longitudinal section of an older endosperm (*end*) showing the enlarged micropylar cells; note the embryo (*em*) with darkened nuclei; × 360.

82. Longitudinal section of a nearly mature seed (seed coat not included); *end*, endosperm; *cl*, cutinized layer; *em*, embryo; × 273.

PLATE 8. AEGINETIA INDICA LINNÆUS

FIG. 83. Portion of a transverse section of a young root showing early beginning of a branch root (cells with darkened nuclei); *co*, cortex; *pi*, pith; *p ph*, primary phloëm; × 240.

84. Portion of a transverse section of an older root showing the primordium of the branch root within the cortical tissue of the mother root; × 240.

85. Transverse section of a secondary root showing more compact and active cortical cells on its lower side; note the spongy character of the cortical cells on the opposite side; *ep*, epidermis; *co*, cortex; *p ph*, primary phloëm; *pi*, pith; × 240.

86. Further differentiation of the lower cortical cells of a secondary root in the formation of the secondary tubercle; note the vascular bundles (*vb*); × 240.

87. Portion of a section of a primary tubercle showing primordium of a scape still within the thin cortical tissue (*co*); *sl*, scale leaf rudiment; × 75.

88. An older scape emerging from the primary tubercle with young lateral scale leaf (*sl*); *vb*, vascular bundle; × 75.

89. Diagram of a section of a primary tubercle showing young scape emerging from its lateral side; axillary pedicel (*ped*) already differentiated; *m ax*, main axis to the scape; *sl*, scale leaves; × 18.

PLATE 9. AEGINETIA INDICA LINNÆUS

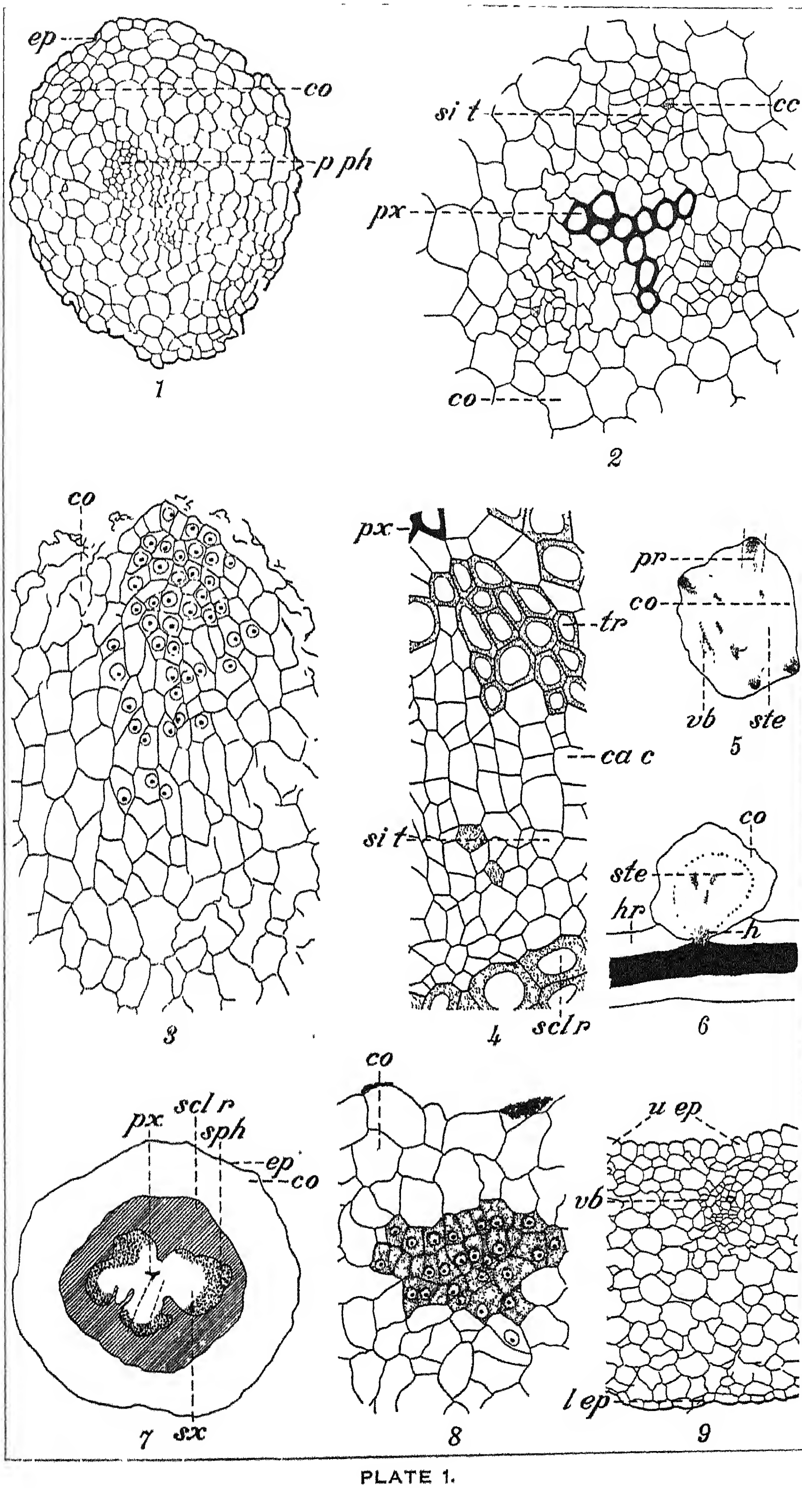
FIG. 90. Ratoon canes (POJ 2878) dug April 28, 1934, with fresh parasite producing young scapes. Reduced to about one-half its natural size.

91. *A*, a portion of a root of the parasite developing scapes (*sc*) at its side and injured apex without forming tubercles, × 4. *B*, tubercle (*tub*) forming a scape (*sc*); (*br*) branch roots, × 2.

PLATE 10. AEGINETIA INDICA LINNÆUS

FIG. 92. The parasite in bloom on ratoon canes (POJ 2878) June 14, 1934, about two and one-half months after the canes had been harvested. Reduced to about one-half its natural size.

93. The growth of the parasite (*pa*) one month after the seedling (*hs*) cane (POJ 2878) had been inoculated with fresh viable seeds. The specimen was preserved in 10 per cent formalin before it was photographed. Reduced to about one-half its natural size.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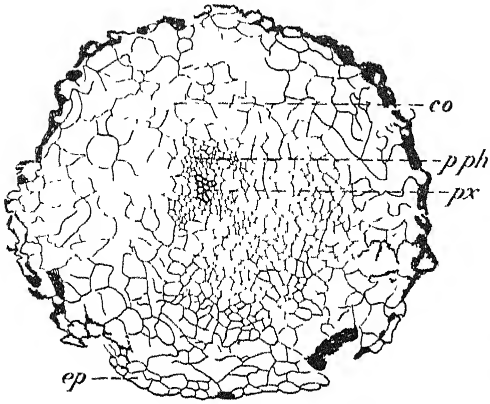

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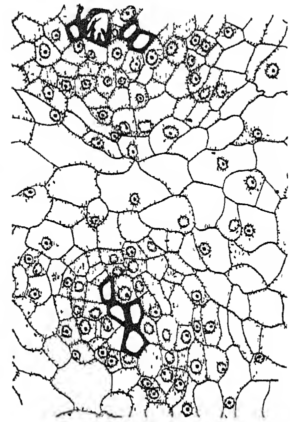

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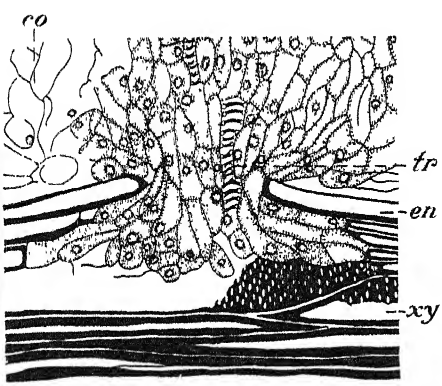

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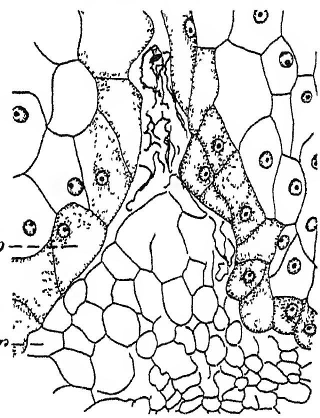

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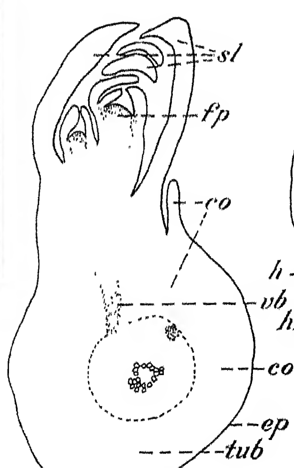

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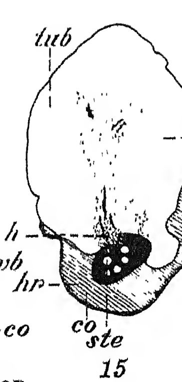

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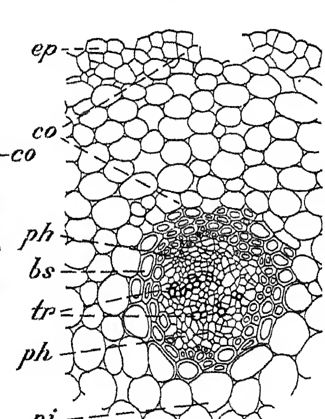

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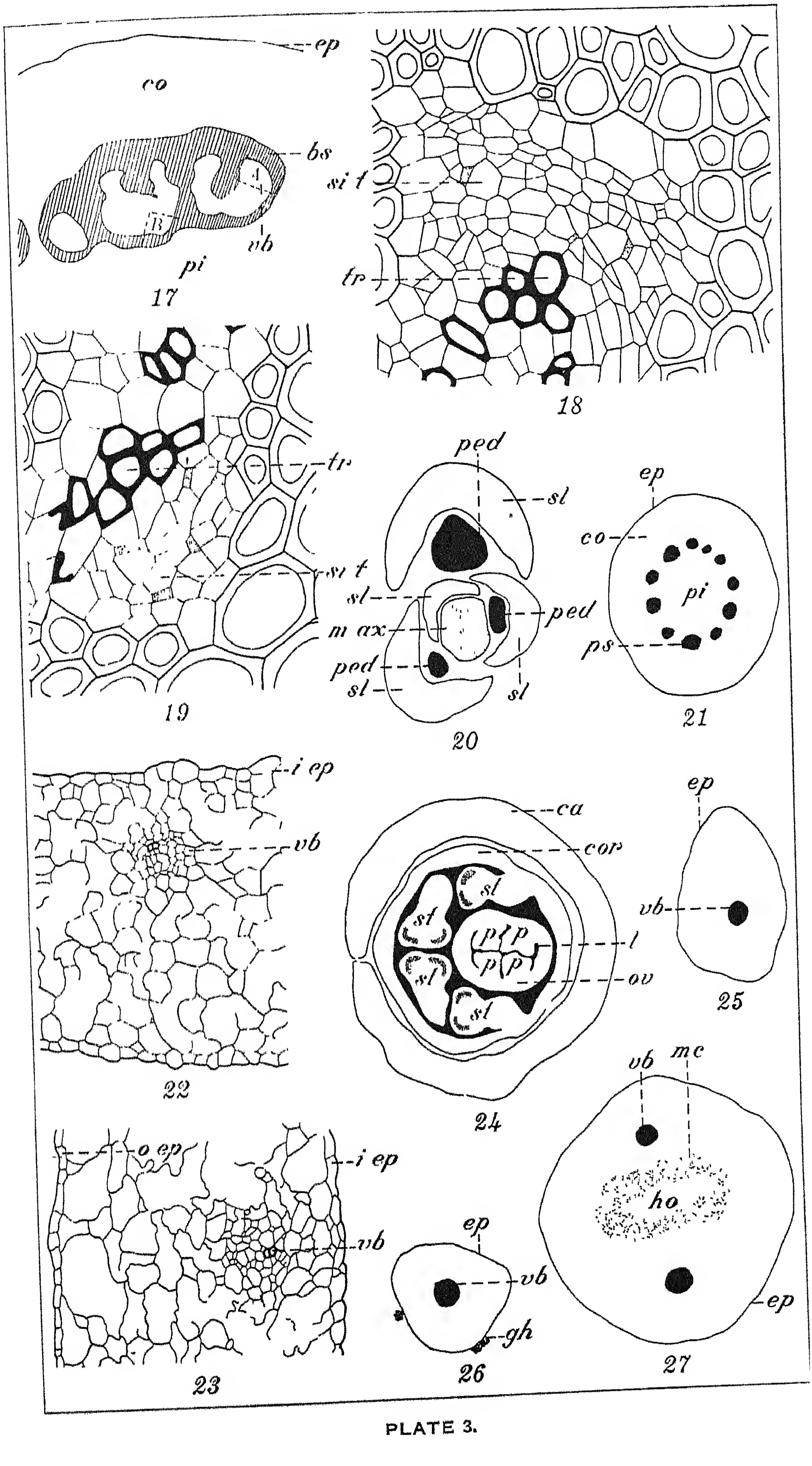
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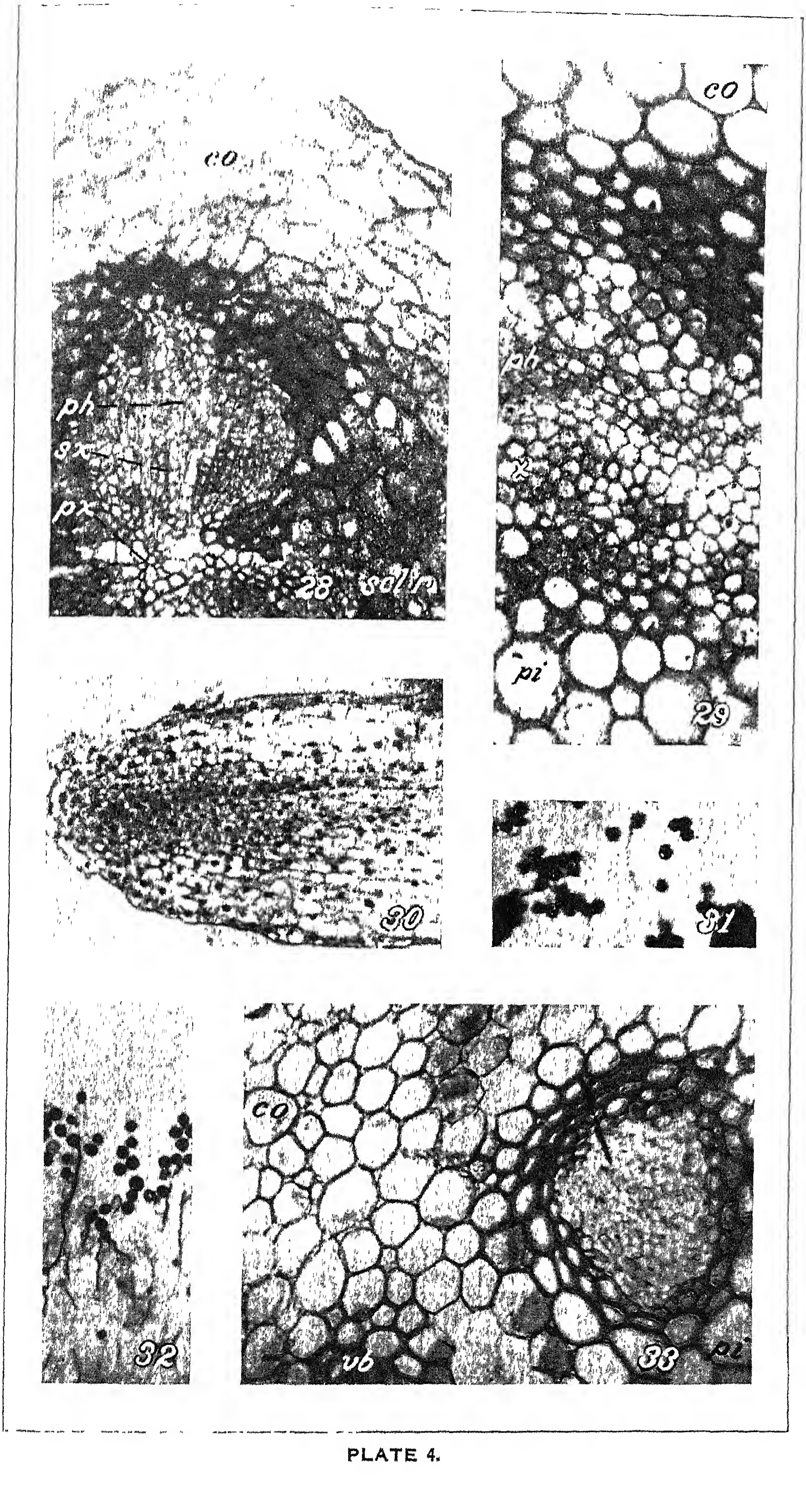
PLATE 3.



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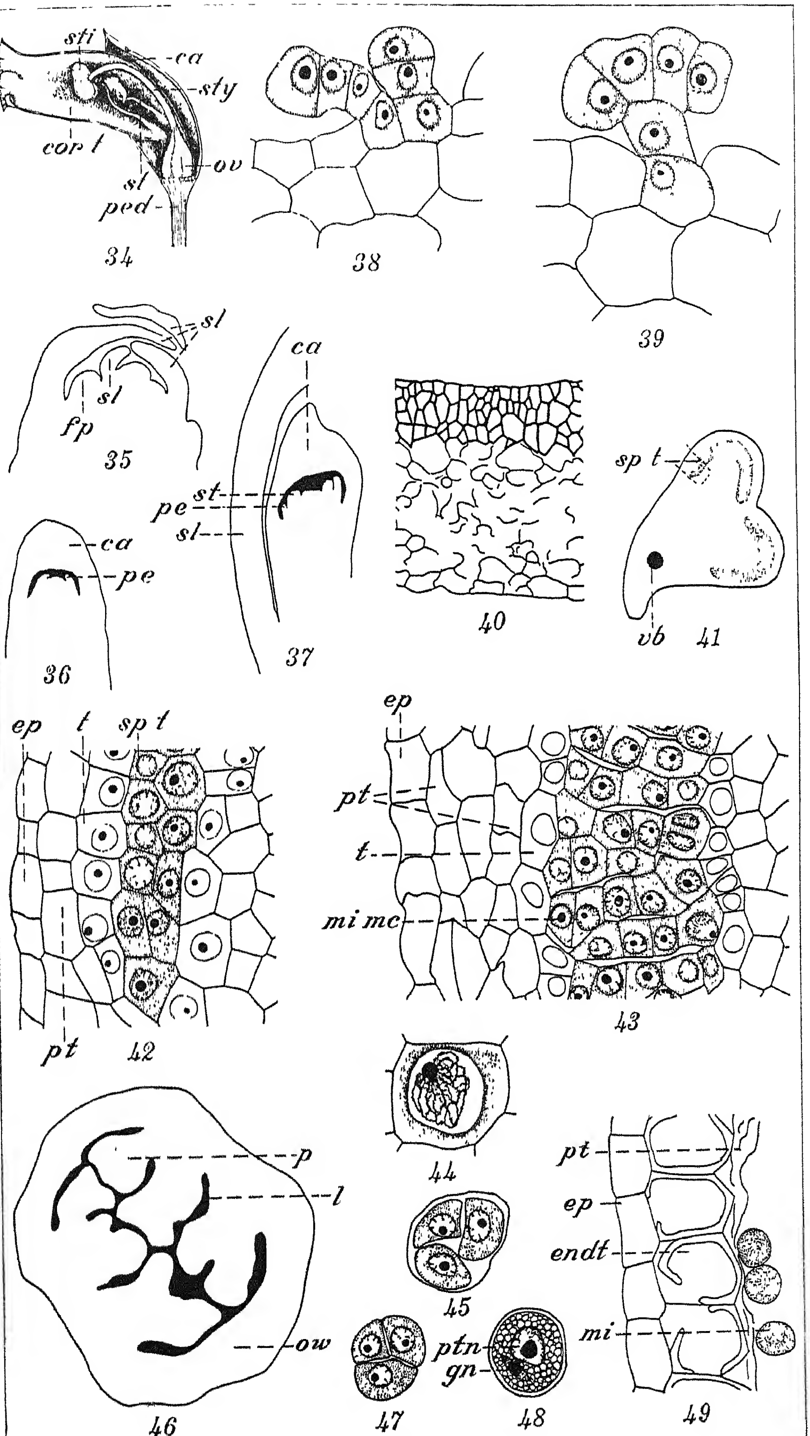
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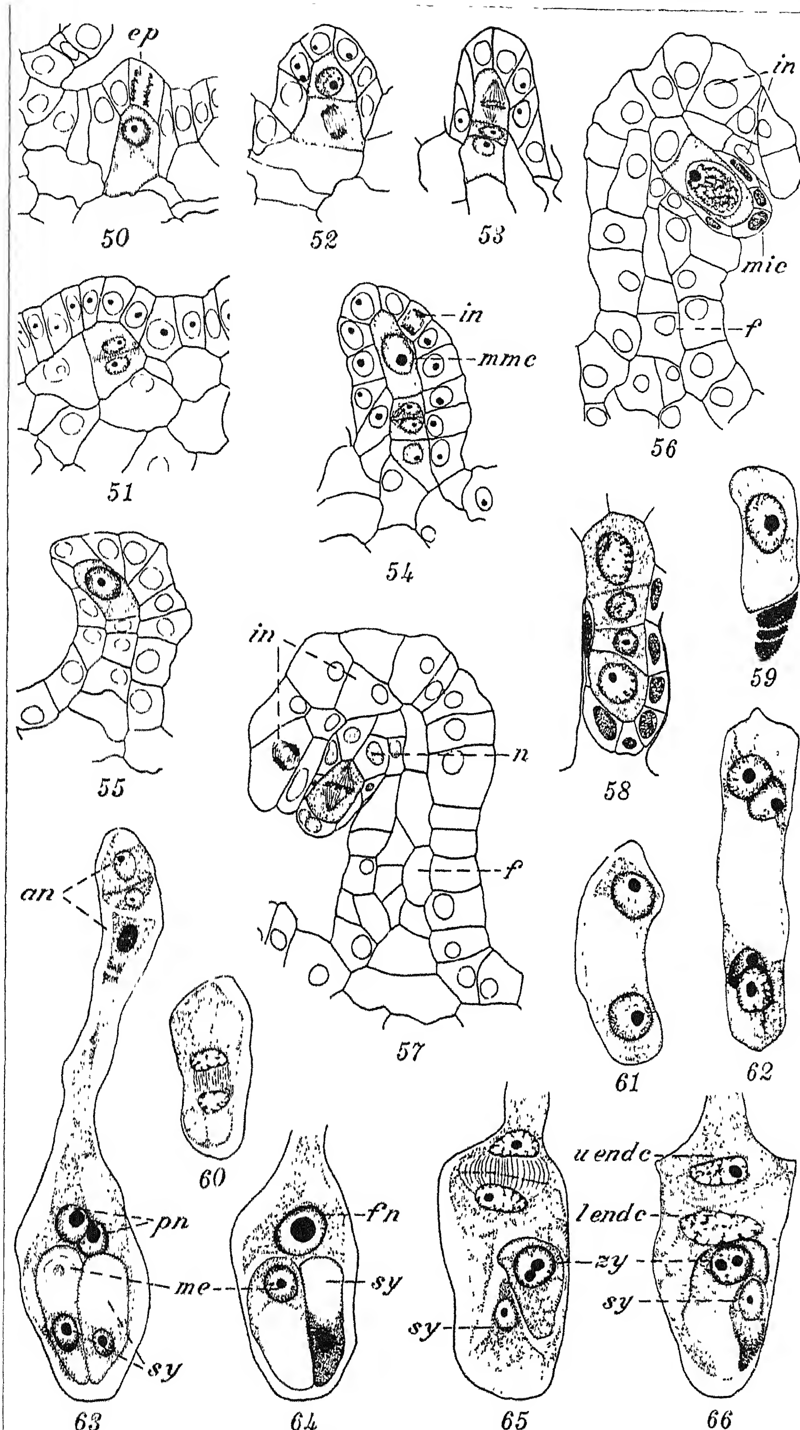
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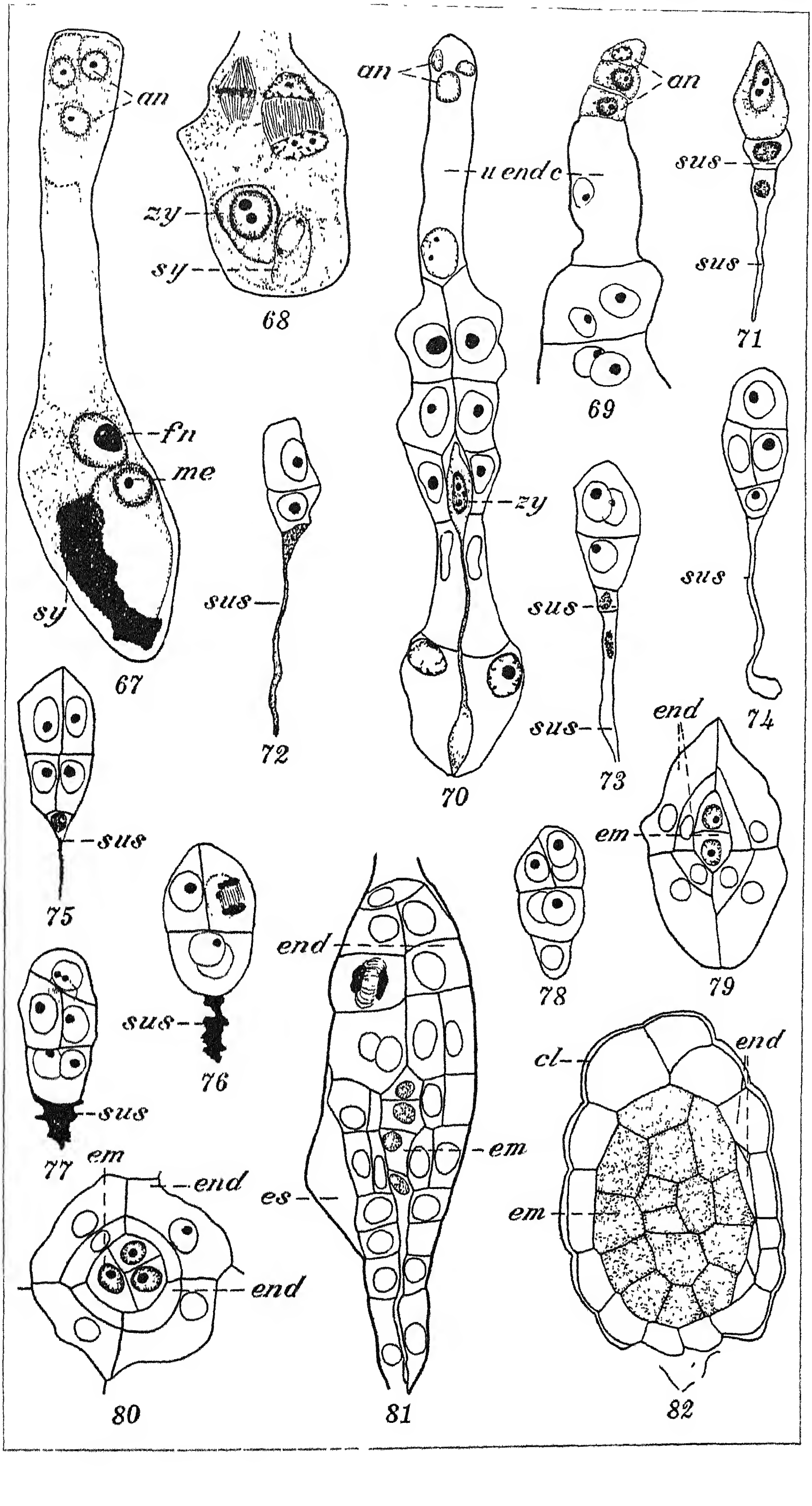
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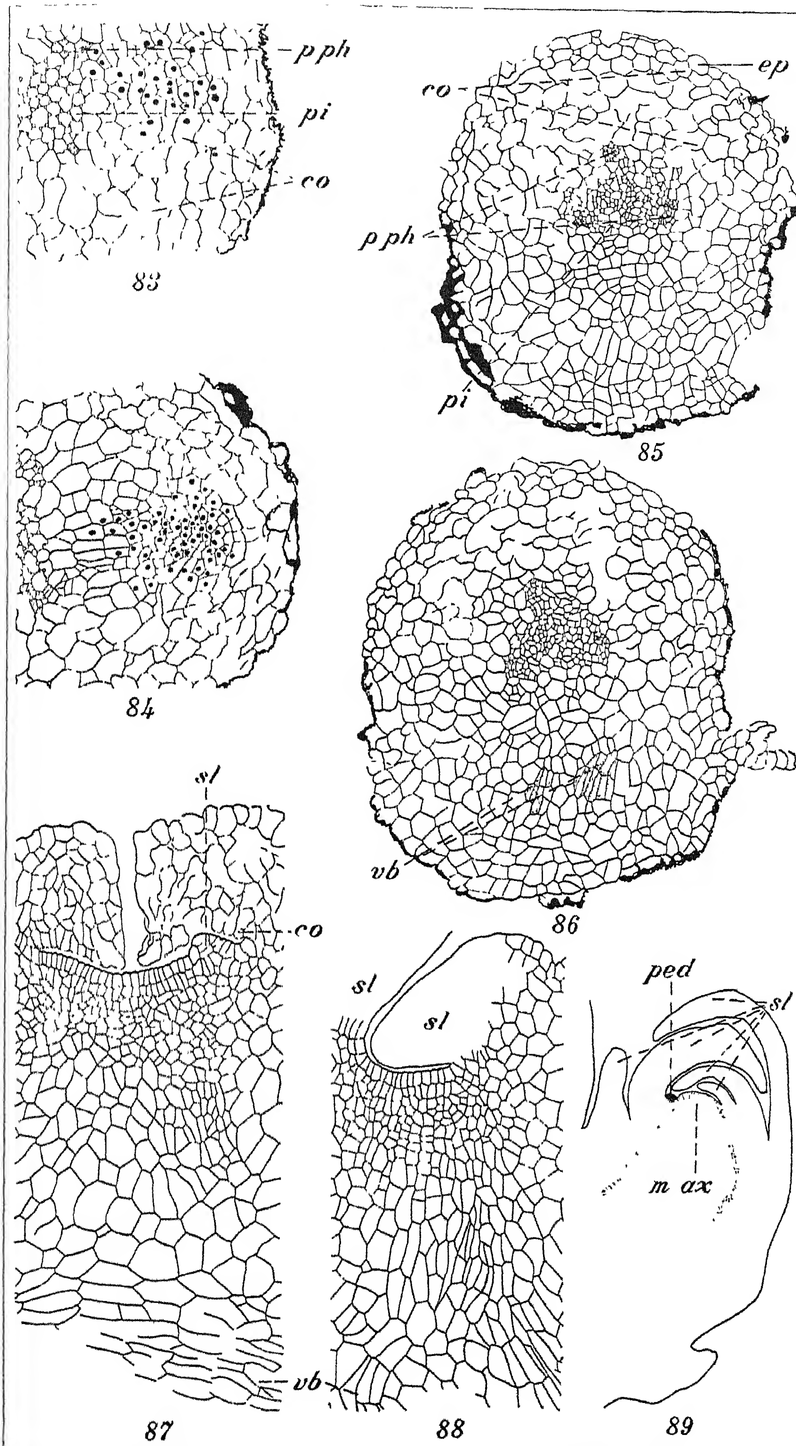
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PLATE 8.

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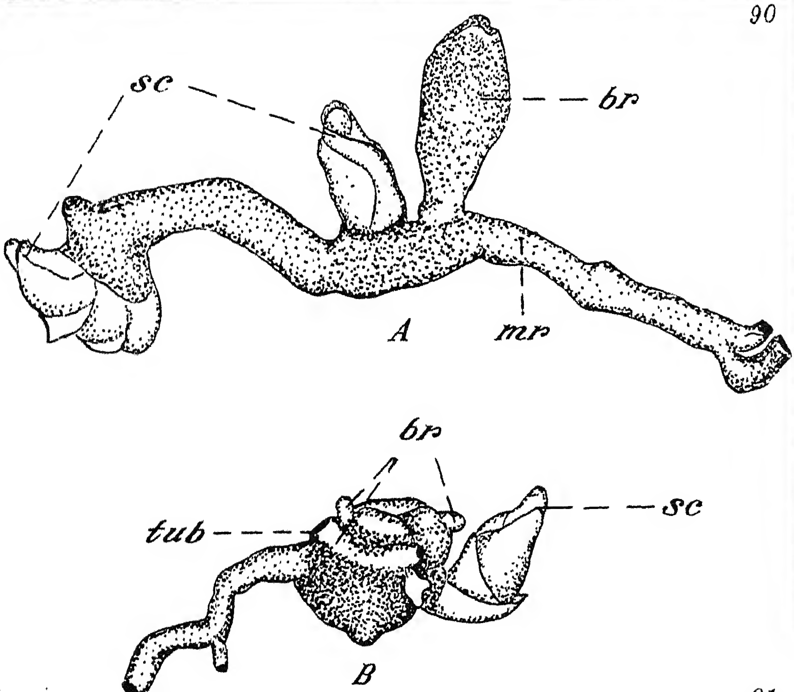

91

PLATE 9.

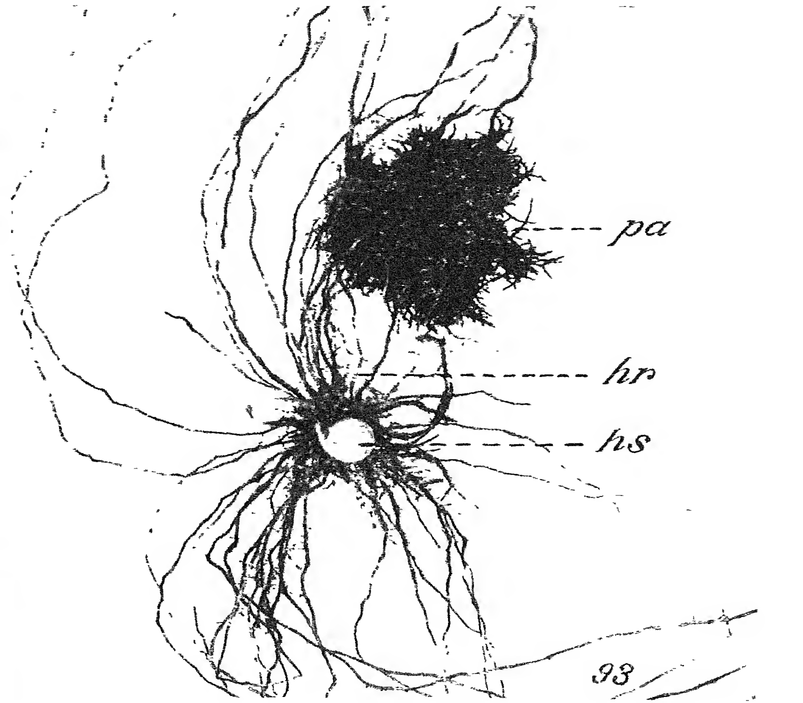

PLATE 10.

NEW OR NOTEWORTHY PHILIPPINE ORCHIDS, V

By Oakes Ames

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and

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TEN PLATES

The present paper is essentially similar to its predecessors.[1] It consists of descriptions of one new species and four new varieties. Four previously described species, *Dendrobium cerinum, Bulbophyllum Lobbii, Renanthera elongata,* and *Trichoglottis Guibertii,* are for the first time credited to the Philippine Islands with certainty. *Dendrobium anosmum* var. *Dearei* and *Dendrobium anosmum* var. *Huttonii,* which were known only from their original descriptions, were recently rediscovered. *Dendrobium Schuetzei,* which is known only from Agusan and Surigao Provinces, Mindanao, is for the first time illustrated in color and redescribed. All the descriptions in the text have been prepared from living specimens, and all the illustrations were made by Mr. Pedro Ramos, draftsman of the National Museum Division, Bureau of Science. All the types of the new species and varieties have been deposited in the Philippine National Herbarium, Bureau of Science, formerly called Herbarium of the Bureau of Science, with isotypes in the herbarium of the senior author. Available isotypes will be distributed to the herbarium of the New York Botanical Garden and to other herbaria.

Genus DENDROBIUM Swartz

DENDROBIUM ANOSMUM Lindl. var. **DEAREI** (Rolfe) Ames and Quis. comb. nov. Plate 1, fig. 1; Plate 5.

Dendrobium superbum Reichb. f. var. *Dearei* Rolfe in Lindenia 6 (1891) 52, *sub t. 264;* Rolfe in Orch. Rev. 14 (1906) 177, *fig. 22;* Ames, Orch. 2 (1908) 187.

[1] Philip. Journ. Sci. 44 (1931) 369–383, 16 pls.; 47 (1932) 197–220, 29 pls.; 49 (1932) 483–504, 28 pls.; 52 (1933) 443–473, 17 pls.

? *Dendrobium macranthum* Hook. var. *album* NAVES, Novis. App. (1882) 233.

La variété DEAREI *a les fleurs du blanc le plus pur, avec les segments très pointus.*

In habit similar to the species, but the stems are shorter and more slender. The flowers are pure white, except the naphthalene yellow throat of the lip, slightly fragrant, 8.5 to 9.5 cm across. The sepals lanceolate, 5.2 to 5.3 cm long, 1.5 to 1.6 cm wide, the dorsal acute, the laterals acuminate and forming a mentum or short spur which is pale greenish. Petals elliptic, acute, about 5 cm long, 3.2 cm wide.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Phil. Nat. Herb. 102 Quisumbing*, March 9, 1934. This is the second time that this variety has come to the attention of the junior author. The first instance was a plant belonging to Mrs. Stewart, collected by her near Baguio in March, 1926. The second plant, the subject of this description, was originally collected from the mountains of Rizal Province and was found mixed with typical *Dendrobium anosmum*.

This is one of the purest white dendrobes known, and is endemic to the Philippines.

DENDROBIUM ANOSMUM Lindl. var. HUTTONII (Reichb. f.) Ames and Quis. comb. nov. Plate 1, fig. 3.

Dendrobium superbum Reichb. f. var. *Huttonii* REICHB. F. in Gard. Chron. (1869) 1206; ROLFE in Lindenia 6 (1891) 52, sub. *t. 264;* Orch. Rev. 29 (1921) 116; WILLIAMS, Orch. Grow. Man. ed. 7 (1894) 364; AMES, Orch. 2 (1908) 187.

Perigonio candido, labelli disco ac ungue purpureis.

A very striking novelty. The flowers are clear white. The disc of the lip bears two beautiful purplish blotches, and its base is of the same colour. For this beautiful thing we have to thank Messrs. Veitch, who obtained it through their late excellent collector, Mr. Hutton, from the Malayan Archipelago.

In habit and general features similar to the species. The stems are comparatively shorter and more slender. The flowers are beautiful, showy, slightly fragrant, and about 8.5 cm across. They resemble those of the former variety in being pure white throughout but have the throat of the labellum dark purple.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Phil. Nat. Herb. 103 Quisumbing*, March 10, 1934. The plant was originally collected by orchid peddlers among the typical plants of *Dendrobium anosmum*, from the mountains of Rizal Province, Luzon.

This, like the former variety, is very rare and beautiful, having been seen by the junior author in Manila gardens but once during his many years of study of orchids. It is characterized by having white flowers with the throat of the labellum dark purple. This particular variety has also been reported from the Malay Archipelago.

DENDROBIUM CERINUM Reichb. f. Plate 1, figs. 4 and 5; Plate 3, figs. 1 to 10; Plate 9, fig. 2.

Dendrobium cerinum REICHB. F. in Gard. Chron. II 12 (1879) 554.

Dendrobium cerinum, n. sp.—Caule teretiusculo demum multum sulcato calamum aquilinum crasso; racemis brevibus paucifloris densifloris; sepalo impari ovato oblongove acutiusculo; sepalis lateralibus triangulo semiovatis obtuse acutis, in mentum teretiusculum apice abrupte acutum extensis; tepalis ovatis obtuse acutiš; labelli ungue cum cornu retrorso in medio, lamina subrotunda laevi, antice minute denticulata, columna clavata—Flores cerini, nitidi, ochroleuci, brunneo lavatis. Lineae fuscae radiantes in basi laminae labelli.—Ex aff. Dendrobii sanguinolenti; labello tamen ac mentum multum recedens. Ex archipelago Sondaico viv. misit el. Burbidge ad dominos Veitch.

This is very near the well-known buff-coloured variety of Dendrobium sanguinolentum. The stem is half as thick as one's little finger, and much furrowed when old. It bears dense racemes of from four to six flowers, whose chin is thinner and abruptly acute, not thick and retuse as in the compared species. Ovaries and pedicels light rose. Sepals and petals light yellowish-ochre coloured, shaded with brown. The central rib of the mentum is light purple. The lip is just alarming. It mimics that of Dendrobium sanguinolentum, having a strong retrorse tooth on its claw. The blade, however, shows the best differences; it is oblong, not three-lobed, and its border, in lieu of being totally entire, shows numerous minute teeth on its anterior edge. The colour is light ochre with radiating brown lines at the transition of the blade into the claw. The whole flower is of very firm texture, and shining as if made from wax. The lip has sometimes a certain tendency to become three-lobed. I have to thank for materials Messrs. Veitch, who tell me that the plant was collected in the Malayan Archipelago by Mr. Burbidge. It flowered in July and September. H. G. REICHENBACH F.

Stems terete, aggregated, subpendulous, fusiform, 4.5 to 17 cm long, 5.5 to 10 mm in diameter at the widest portion, angled and sulcate when dry, the nodes 1 to 2.5 cm distant. Leaves distichous, elliptic-lanceolate or oblong-lanceolate, 6 to 11 cm long, 1.8 to 3.2 cm wide, nervose, membranaceous, pale green, narrowed to the acute apex. Leaf sheaths green, membranaceous, deciduous on the lower part of the plant. Racemes short, pendulous, laxly few-flowered, up to 4.5 cm long, 2- to 3-flowered. Flowers 3.5 to 3.8 cm long, 3.5 to 3.8 cm across, odorless, with slightly inflexed spur. Bracts pellucid, minute, membranaceous,

1.5 to 2 mm long. Pedicellate ovary 2.3 to 2.5 cm long, slender. Lateral sepals very obliquely oblong-lanceolate, acute, 1.4 to 1.6 cm long, 7-nerved, forming with the column foot a mentum or spur which is elongate, slightly curved, obtuse, 1.9 to 2 cm long. Dorsal sepal lanceolate-ovate, subacute, 1.4 to 1.6 cm long, 7 to 8 mm wide, 7-nerved. Petals spreading, oblong-elliptic, rounded and minutely apiculate at the apex, 14.5 to 15.5 mm long, 7.5 to 8 mm wide, 5-nerved. Labellum simple, elongate, about 3 cm long, attached to the column-foot; claw linear-oblong, sharply sigmoid, with a retrorse tooth in the middle; lamina round-ovate, about 1.8 cm long, 1.7 cm wide at the broadest portion (when expanded), broadly rounded or slightly retuse at the apex, crenulate-denticulate on the margin; disc provided with a single broad rather obscure central fleshy band which is glabrous and extends from the column-foot nearly to the apex of the labellum. Column very short and stout, tridentate. Anther subquadrate-ovoid, about 3 mm long. 3.5 mm wide.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 104 Quisumbing*, February 28, 1933. The living plants were originally gathered by Novaliches orchid peddlers from the mountains of Rizal Province, Luzon, back of the town of Antipolo. The plants are now being cultivated in the Bureau of Science orchid house and in the gardens of Mrs. Remedios C. Gonzales. The description was based on Bureau of Science material which flowered in Manila February 28, 1933. The flowers are fairly large and odorless, and remain fresh for three to four days. Pedicellate ovary apple green; sepals straw yellow; petals and labellum chalcedony yellow; spur straw yellow with shades of ecru-olive and some very pale purple, light lumiere green at the tip.

In the herbarium of the senior author is a colored sketch of this species from the Reichenbachian collection in Vienna. Thanks to this authentic record, one more obscure species is now shown to be represented by a recent definite collection.

Apparently the original collection was destitute of leaves. It was described (and shown) as having light rose or reddish pedicellate ovaries whereas the recent collection has the pedicellate ovary apple green.

A species closely allied to *Dendrobium Guerreroi* Ames and Quis. but differing from it in its fusiform, short, angled stems, in its few-flowered racemes, in the color of the flowers, in the

shape of the spur, and in its denticulate-margined labellum with ovate-rounded lamina.

DENDROBIUM PHILLIPSII sp. nov. Plate 1, figs. 6 and 7; Plate 3, figs. 11 to 19; Plate 6, fig. 1.

Aff. D. Fairchildae. Caules penduli, aggregati, teretes, tenuiter-fusiformes, 45 ad 60 cm longi, 5 ad 7 mm in diametro. Folia lanceolata, acuta, papyracea, decidua, 11.5 ad 12.5 cm longa, 1.5 ad 2 cm lata. Racemi brevissimi, pauciflori; bracteae lanceolatae, acutae, 5 ad 6.5 mm longae. Sepala lateralia obliquissime triangulari-ovata, acuta, 1.6 ad 1.7 cm longa, columnae pedem secundum 1.2 ad 1.3 cm lata; mentum valde elongatum, obtusum, ad apicem haud inflexum 2.7 ad 3 cm longum. Sepalum dorsale ovato-lanceolatum, subacutum vel obtusum, 1.8 ad 1.9 cm longum, 9 ad 10 mm latum. Petala late oblonga vel oblongo-elliptica, apice rotundata, 1.7 ad 1.8 cm longa, circiter 8 mm lata. Labellum simplex, ovato-oblanceolatum cum parte inferiore oblonga sensim dilatata, antice ovato-triangulare, acutum, circiter 3.5 cm longum et 1.5 cm latum. Gynostemium brevissimum, crassum, apice tridentatum cum stelidiis lateralibus triangulari-ovatis leviter recurvatis et dente medio tenui, in pedem elongatum extensum.

Stems pendulous, crowded, terete, elongate, fusiform, 45 to 60 cm long, 5 to 7 mm in diameter, reddish-brown, smooth; internodes 2.5 to 4.5 cm long. Leaves lanceolate, acute, 11.5 to 12.5 cm long, 1.5 to 2 cm wide, papery, deciduous. Racemes short, few-flowered, 3 to 4 cm long; bracts lanceolate, acute, greenish, 5 to 6.5 mm long, 3 to 3.5 mm wide when expanded. Flowers about 1.8 cm across. Pedicellate ovary about 3 cm long. Lateral sepals very obliquely triangular-ovate, acute, 1.6 to 1.7 cm long, 1.2 to 1.3 cm wide along the column-foot; the mentum or spur stout, elongate, obtuse, straight, 2.7 to 3 cm long, 1.2 to 1.3 cm wide near its base. Dorsal sepal broadly ovate-lanceolate, subacute or obtuse, 1.8 to 1.9 cm long, 9 to 10 mm wide. Petals broadly oblong or oblong-elliptic, rounded at the apex, 1.7 to 1.8 cm long, about 8 mm wide. Labellum simple, ovate-oblanceolate with the lower part gradually narrowed and adorned with a low transverse lacerate ridge, about 3.5 cm long, triangular-ovate near the apex, acute, about 1.5 cm wide. Gynostemium very short, broad, with the lateral stelidia triangular-ovate and slightly recurved, and middle tooth slender. Foot elongate.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 85618 Quisumbing*, February 14, 1933. The above description was based upon a living flowering specimen sent to the junior author by Mr. L. H. Phillips, who collected it from the hills of Bukidnon, Mindanao. The flowers are white except the spur and the throat of the labellum which are apricot yellow.

This species is allied to *Dendrobium Fairchildae* Ames and Quis., but differs from it in having smaller and more-slender stems, straight spur, and broadly ovate-oblanceolate labellum.

This species is dedicated to Mr. L. H. Phillips, formerly of the Philippine Packing Corporation at Bukidnon, Mindanao. While he was there, he spent considerable time and effort in collecting orchids during week ends and holidays, and we owe to him our present knowledge of the orchid flora of Bukidnon.

DENDROBIUM SCHUETZEI Rolfe. Plate 1, fig. 2; Plate 3, figs. 20 to 27; Plate 6, fig. 2.

Dendrobium Schuetzei ROLFE in Orch. Rev. 19 (1911) 224, 20 (1912) 289, 308, 337, *fig. 47*, in Gard. Chron. III 50 (1911) 42, III 52 (1912) 229, fig. 102; G. WILSON in Orch. World 3 (1912) 19, *t.*; ROLFE in Bot. Mag. 139 (1913) *t. 8495*; AMES Orch. 5 (1915) 138, 7 (1922) 96, in Merr. Enum. Philip. Fl. Pl. 1 (1924) 354.

The original description reads as follows:

"DENDROBIUM SCHUETZEI ROLFE.—This is another striking Dendrobium, of the D. Dearei group, which has been introduced by Messrs. Sander & Sons, St. Albans, and of which a technical description has been prepared. It has very large white flowers, the petals are obovate-orbicular in shape, and the lip strongly three-lobed, with broadly-rounded side lobes, and the front lobe broadly obovate or nearly orbicular, with a distinct apiculus. The petals and lip are much broader than in D. Dearei, and altogether different in shape. It should prove a great acquisition." Rolfe, Orch. Rev. 19 (1911) 224.

Rolfe's Latin diagnosis, Bot. Mag. (1913) t. 8495, reads as follows:

Herba epiphytica, 15–40 cm. alta. *Caules* erecti, subcylindrici, medio incrassati, sulcati, basi attenuati, dense foliati. *Folia* subpatentia, elliptico-oblonga, obtusa, coriacea, 8–10 cm. longa, 2.5–3.5 cm lata. *Pedunculi* subterminales, breves, pauciflori. *Bracteae* oblongae, subacutae, breves. *Pedicelli* circiter 4 cm longi. *Flores* magni, speciosi, albi, labelli basi viridi. *Sepala* subpatentia; posticum oblongo-lanceolatum, acuminatum, 3 cm. longum; lateralia triangularia, acuta, carinata, 3–5 cm. longa; mentum obtusum, 1.3 cm. longum. *Petala* late ovato-orbicularia, apiculata, 4.5–5.5 cm. longa, 3.5–4 cm. lata. Labellum trilobum, 4–4.5 cm. longum; lobi laterales subincurvi, late rotundati; lobus intermedius subrecurvus, late obovatus, truncatus vel emarginatus, apiculatus, crenulatus, 3.5–4 cm. latus; discus basi obtuse carinatus. *Columna* lata, 6 mm. longa; alae falcato-oblongae.

Dwarf in habit; the stems erect, leafy, short, stouter at the middle, narrowed to the base, 15 to 30 cm long or more, 1.1 to 1.5 cm in diameter at the widest portion. Leaves oblong-lanceolate or elliptic-lanceolate, subacute or obtuse at the apex, narrowed to the base, subcoriaceous, 6 to 11 cm long, 1.6 to 3 cm wide. Raceme 3- to 5-flowered; bracts triangular, about 2 mm long. Flowers showy, odorless, 6 to 6.5 cm across, pure white except the throat of the lip which is emerald green with a few purple stains at the base. Pedicellate ovary greenish white, 5.5 to 6 cm long. Lateral sepals triangular, acutely acuminate, keeled, 3.5 to 4 cm long, 1.5 to 1.8 cm wide. Dorsal sepal lanceolate, sharply acuminate, 3.5 to 3.8 cm long, about 2 cm wide along the column-foot. Petals suborbicular-obovate, broadly obtuse or rounded, apiculate, 4 to 4.7 cm long, 3.8 to 4.2 cm wide. Labellum distinctly 3-lobed; lateral lobes semiobovate, broadly rounded, somewhat incurved, about 2.7 cm long and 1.1 cm wide near the apex; middle lobe somewhat recurved, broadly flabellate-obovate or nearly orbicular, truncate, or slightly retuse, apiculate, 2.4 to 2.6 cm long, 3.2 to 3.7 cm wide; the whole labellum pure white except the throat between the lateral lobes which has a patch of full green-yellow with short Victoria lake lines at the base. Spur white, pale olivine at the tip, short, obtuse, 1.3 to 1.4 cm long. Column broad and short, white, green dotted with Victoria lake at the base. Anther subquadrate in outline, white. Pollinia narrowly oblong.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 82 Quisumbing*, February 13, 1933, originally collected by Mr. L. Hachero from Surigao, Mindanao, presented to Doctor Quisumbing, and now growing in Bureau of Science orchid house. MINDANAO, Surigao, *W. Lyon s. n.*, February, 1917.

A species with the habit of *Dendrobium Dearei* Reichb. f. and *D. Sanderae* Rolfe and allied to them, but differing strikingly in the short, obtuse spur. In addition to the different spur, this species differs from *D. Dearei* in having much larger flowers with different petals; it differs from *D. Sanderae* in the color and details of the flowers.

Genus BULBOPHYLLUM Thouars

BULBOPHYLLUM LOBBII Lindl. Plate 2, fig. 1; Plate 4, figs. 1 to 8; Plate 7, fig. 1.

Bulbophyllum Lobbii LINDL. in Bot. Reg. 33 (1847) sub *t. 29* (as *B. Lobii*); W. J. HOOKER in Curtis's Bot. Mag. 76 (1850) *t. 4532.*

The original description reads as follows:

BOLBOPHYLLUM LOBII; folio petiolato obovato-oblongo coriaceo, pedunculo unifloro folio breviore, pedunculo nudo unifloro folio breviore, sic basi subglanduloso e bracteis squamaeformibus cucullatis falcatis subglandulosis erumpente, sepalis oblongis acutis lateralibus falcatis, petalis conformibus minoribus reflexis, labello longe unguiculato cordato ovato acuto canaliculato apice recurvo. Lindl.

Rhizome creeping, rather stout, 5 to 7 mm in diameter, with numerous simple or rarely branched roots which are 1 to 1.5 mm in diameter. Pseudobulbs pyriform-cylindric, asymmetrically curved, remote, rugose, monophyllous, sessile, 4 to 4.5 cm long, 1.7 to 1.9 cm in diameter at the widest portion near the base. Leaves oblong-elliptic, acute, coriaceous, rigid, about 12 cm long, 4.6 cm wide; the petioles about 3 cm long. Scape arising from the side of each pseudobulb, its base sheathed with imbricated, lanceolate, membranaceous bracts, which are 2.2 to 2.8 cm long; the peduncles provided with bracts, which are 1.5 to 2 cm long. Pedicellate ovary primuline yellow and minutely spotted with dark purplish brown, 4.5 to 5 cm long, the ovary conspicuously ridged. Flowers showy, the largest of all known Philippine bulbophyllums, solitary, 7.5 to 8.5 cm across. Lateral sepals strongly falcate, lanceolate, gradually narrowed to the acute apex, 7.8 to 8 cm long, about 2 to 2.3 cm wide at the widest portion near the base, 13-nerved, the anterior portion circinate. Dorsal sepal greatly elongated, narrowly lanceolate, gradually narrowed to the acute apex, about 9.5 cm long, 1.5 cm wide at the widest portion near the base, 11-nerved. Petals similar to the lateral sepals, 7.1 to 7.7 cm long, 1.1 to 1.2 cm wide at the widest portion near the base, 9-nerved. Labellum triangular-lanceolate, strongly recurved, fleshy, mobile, acuminate, cordate at the base, 2.8 to 3 cm long, 1.1 to 1.2 cm wide. Column very short, stout, free portion 9 to 10 mm high, laterally winged, produced into an elongated curved foot about 1.1 cm long, of which the terminal portion is free and bears at its apex the mobile labellum. Pollinia subglobose.

LUZON, Benguet Subprovince, Baguio, Mrs. G. H. Fairchild's gardens, *Bur. Sci. 85568 Quisumbing*, March 23, 1932. The living plants were originally collected by Mrs. G. H. Fairchild near Baguio.

Bulbophyllum Lobbii is the largest-flowered *Bulbophyllum* ever reported from the Philippines and is closely allied to *Bulbophyllum calossum* Ridl.

Genus PHALAENOPSIS Blume

PHALAENOPSIS MARIAE Burbidge var. **ALBA** Ames and Quis. var. nov. Plate 2, figs. 3 and 4; Plate 4, figs. 9 to 17; Plate 7, fig. 2.

Haec varietas floribus omnino albidis haud striatis a *P. Mariae* differt.

In habit and in leaves similar to the species. The leaves, shining on the upper surface, dark green, 22.5 to 24 cm long, 5.5 to 7.7 cm wide. Scapes slender, sparingly branched, few-flowered, 10 to 20 cm long. Flowers odorless, 5 to 8 mm distant, 3.5 to 4 cm across, without bars and entirely pure white except at their apices which are light green-yellow and the inner basal portion of the lateral lobes of the labellum which is empire yellow. Pedicellate ovary white, about 12 mm long. Lateral sepals spreading, obliquely elliptic-ovate, obtuse, apiculate, 1.9 to 2 cm long, 1 to 1.1 cm wide. Dorsal sepal narrower, erect, broadly lanceolate-elliptic, obtuse, 1.9 to 2 cm long, 8.5 to 9 mm wide. Petals lanceolate-elliptic, obtuse, 1.7 to 1.8 cm long, 8.5 to 9 mm wide. Labellum fleshy, 3-lobed; lateral lobes erect in natural position, obliquely subquadrate-oblong, incurved towards the column, white with empire yellow stain on the inner basal portion, 5 to 6 mm long; middle lobe pure white, spatulate-obovate, 11 to 12 mm long, 7 to 8 mm wide at the widest portion, prominently keeled in the middle longitudinally, the keel conspicuously clothed with hairs on the anterior part. Column pure white, about 7 mm long.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 85707 Quisumbing,* June 21, 1933. The description is based upon a living plant (now growing in the Bureau of Science orchid house), which was donated to the junior author by Mr. L. H. Phillips, who collected it from the hills of Bukidnon, Mindanao.

The variety is characterized by having pure white flowers with a complete absence of bars on the sepals and petals.

The plate in Bot. Mag. t. 6964 shows a very similar middle lobe of the lip, and the length of the pedicellate ovary is variable in specimens in the herbarium of the senior author.

Genus AËRIDES Loureiro

AËRIDES LAWRENCIAE Reichb. f. var. **FORTICHII** Ames and Quis. var. nov. Plate 2, fig. 2.

Habitu speciei similis, floribus albidis differt.

A variety resembling the species in habit and general features. Leaves 15 to 22.5 cm long, 2.8 to 3.3 cm wide. Inflorescence

curving, about 42 cm long including the peduncles. Flowers fragrant, 3.1 to 3.2 cm across. Sepals and petals white faintly washed at center with sea-foam yellow, and devoid of purple at the tips. Lateral lobes of labellum white, the tips overlapping below the middle lobe; middle lobe rose-pink, margin denticulate. Spur goose green. Column white. Pedicellate ovary pale dull green-yellow.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 106 Quisumbing,* January 13, 1933. According to Mr. L. H. Phillips, formerly of the Philippine Packing Corporation, Cagayan de Misamis, Mindanao, who furnished the junior author with a living plant in flower, the Hon. Manuel Fortich, representative from Bukidnon, collected two plants from his ranch in Bukidnon Province, Mindanao.

As far as we know, this is the first time a white variety of *Aërides Lawrenciae* has been reported. The variety closely resembles the species in habit and general features, but differs in its white flowers. To Representative Fortich, of Bukidnon Province, this interesting and newly discovered variety is dedicated.

AËRIDES LAWRENCIAE Reichb. f. var. **PUNCTATA** Ames and Quis, var. nov. Plate 2, figs. 5 and 6.

Habitu speciei similis, floribus purpureis punctatis differt.

In habit and general features this variety resembles the species. The flowers are large, fragrant, about 3 cm across. Petals and sepals white tipped with true purple. Lateral lobes of the labellum white, dotted conspicuously with true purple, the dots extending up to the spur; the front lobe of the labellum true purple. The tip of the spur is buckthorn brown.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 107 Quisumbing,* November 12, 1932. The plant was originally collected by Mr. L. H. Phillips in the mountains of Cagayan de Misamis, Mindanao.

This variety is characterized by the conspicuous purple dots on the sides of the lateral lobes of the labellum.

Genus RENANTHERA Loureiro

RENANTHERA ELONGATA Lindl. Plate 2, fig. 7; Plate 4, figs. 18 to 25; Plate 8.

Renanthera elongata LINDL. Gen. & Sp. Orch. Pl. (1833) 218; AMES Orch. 5 (1915) 224, Bot. Mus. Leafl. Harv. Univ. 2 (1934) 31.

Renanthera micrantha BLUME, Rumphia 4 (1848) 54, Mus. Bot. Lugd.-Bat. 1 (1849) 60; REICHB. F. in Walp. Ann. 3 (1852) 566; MIQ. Fl. Ind. Bat. 3 (1859) 698; NAVES, Novis. App. (1882) 240.

Renanthera matutina LINDL. in Bot. Reg. 29 (1843) *t. 41*, G. K. in Bot. Zeit. 1 (1843) 760.

"Caule ramoso, foliis lato-linearibus oblique emarginatis, paniculis elongatis nutantibus, sepalis exterioribus lateralibus internis latioribus spatulatis, labelli limbo ovato basi bicalloso.

"Aërides elongatum. Blume l. c. [Bijdr. 366.]

"Hab. in Java, in rupibus calcareis prope Kuripan, Blume. Flores punicei."

Epiphytic on trees. In habit similar to *Renanthera storiei.* Stems erect, 210 to 215 cm high. Leaves distichous, greenish, oblong-elliptic, unequally bilobed at apex, 6.5 to 11.3 cm long, 2.7 to 4 cm wide, 3 to 4.5 cm distant. Peduncles 11.5 to 11.8 cm long. Panicles many-flowered (50 to 70 or more). Flowers small, of the same color as *Renanthera stoirei* var. *philippinensis,* 13 to 14.5 mm long, 9 to 10.5 mm wide. Pedicellate ovary slender, 9 to 11 mm long. Lateral sepals asymmetrically spatulate, clavate, rather abruptly dilated above, 6.5 to 7 mm long, 3.5 to 4 mm wide above the middle, about 1 mm wide across the claw. Dorsal sepal oblong-oblanceolate, obtuse, 7 to 7.5 mm long, about 3 mm wide at widest portion. Petals very similar to the dorsal sepal but smaller, broadly rounded at the apex, 5.5 to 6 mm long, 2 mm wide. Labellum relatively small, fleshy, 3.5 to 3.75 mm long, deeply saccate-spurred at base; 3-lobed at the apex; lateral lobes transversely subquadrate, broadly truncate, about 1 mm high; the middle lobe strongly recurved, triangular-ovate, subacute, about 1.25 mm long, 1 to 1.10 mm wide; spur cylindric-conic, about 2 mm long. Column minute, 1.5 mm long. Anther broadly ovoid, about 1.5 mm long, 1.25 mm across. Pollinia four.

MINDANAO, Zamboanga Province, on a small island on the east coast of Zamboanga, *Mrs. Kenneth B. Day s. n.,* September, 1932. The plants were epiphytic on trees in mangrove swamps.

This species is characterized by its very small flowers.

Genus VANDA Jones

VANDA MERRILLII Ames and Quis. var. **ROTORII** Ames and Quis. var. nov. Plate 2, fig. 8; Plate 9, fig 1.

Haec varieta floribus omnino badiis neque striatis neque maculatis a *Vanda Merrillii* differt.

In habit and flower parts very similar to the species. The flowers are essentially the same in size; the sepals and petals

are ox-blood red within, and chalcedony yellow on the back; the lateral lobes of the labellum pure white; the middle lobe of the labellum Vandyke red except the base of the auricles which are chalcedony yellow; column naphthalene yellow, and the pedicellate ovary white.

LUZON, Manila, Doctor Rotor's gardens, *Phil. Nat. Herb. 109 Quisumbing*, February 9, 1934.

The plant was originally collected by a friend of Doctor Rotor from a tree along the road between Baler, Tayabas Province, and Cabanatuan, Nueva Ecija Province, Luzon.

This variety resembles var. *immaculata* Ames and Quis. in the complete absence of bars or maculations on the flowers, but differs in the ox-blood red petals and sepals and Vandyke red middle lobe of the labellum.

This variety is dedicated to Dr. A. B. Rotor, a lover of orchids.

Genus TRICHOGLOTTIS Reichenbach f.

TRICHOGLOTTIS GUIBERTII (Linden and Reichb. f.) Ames and Quis. comb. nov. Plate 2, figs. 9 and 10; Plate 4, figs. 26 to 35; Plate 10.

Cleisostoma Guiberti LINDEN and REICHB. F. apud Reichb. f. in Bot. Zeit. 20 (1862) 375, Xenia Orch. 2 (1867) 126, *t. 142*.

Vanda Guiberti LINDL. apud Linden and Reichb. f. in synon.

The present species, which is well figured in Xenia Orch. l. c., appears to be referable to the genus *Trichoglottis* as now interpreted, while the concept *Cleisostoma* Bl. is no longer generally upheld by orchidologists.

Moreover, *Trichoglottis Guibertii* is certainly allied to *T. luzonensis* Ames, both vegetatively and florally. On the other hand, the name *Staurochilus* was founded by Ridley on *Trichoglottis fasciata* Reichb. f. which had previously been referred by Bentham, apparently with logic, to Reichenbach's genus *Stauropsis*.

Such species as *Trichoglottis Guibertii, T. luzonensis, T. Dawsoniana, T. fasciata*, etc., certainly differ from the original conception of *Trichoglottis* in having large flowers with scarcely developed spur, and in having the inflorescences (more or less elongate) either loosely racemose or paniculate.

It seems highly probable that orchidologists will eventually be forced to agree with J. J. Smith, in referring to the genus *Trichoglottis* all these allied and intergrading species.

"Affine *Cleisostomati ionosmo* Lindl. labelli lamina pandurata, pilosula, carina postice bicruri a calcaris fundo in laminae fossam excurrente.

"*Vanda Guiberti* Lindl.

"Panicula multiflora. Flores illis *Vandae Roxburghii* aequales, colore fere *Anselliae*, extus pallide flaveolo-albi. Sepala cuneato-oblonga, obtusa. Tepala subaequalia. Omnia flavida annulis rufis. Labellum basi cum columnae basi connatum auriculis rectangulis hinc unidentatis bidentatisve; lamina pandurata, postice latior, apice emarginata, pilosula. Columna brevis, apice utrinque unifalcis, falcibus velutinis; lamella ovata apiculata cochleata sub fovea.

"Die Berichte über die am 24. September in Brüssel veranstaltete Ausstellung heben als wesentliche Merkwürdigkeit diese, vom Hrn. Director Linden ausgestellte und zunächst *Vanda Guiberti* genannte Orchidee vor.

"In der That ist dieselbe eine sehr merkwürdige acquisition, besonders wenn man erwägt, wie die Cleisostomen bis jetzt keine irgend hübschen Blüthen aufwiesen, es sei denn das doch gar bescheidene *Cl. ionosmum.* Unsere neue Art hat einen mächtigen Blüthenstand von Blüthen, die einen modernen deutschen Vereinsthaler decken, und deren braune Ringe auf Paille Untergrund einen guten Eindruck machen." Reichb. f.

Coarse, stout, epiphyte, approaching *Trichoglottis ionosma* in habit. Roots stout, elongate, glabrous. Stems elongate, 50 to 70 cm long, 10 to 14 mm in diameter, subterete. Leaves distichous, oblong-ligulate, 14 to 28.5 cm long, 2.5 to 3.3 cm wide, coriaceous, 3 to 3.5 cm distant, dark green, unequally bilobed at the apex with obtuse lobes. Peduncles rigid, erect when occurring on erect stems and rather pendent when on drooping stems, 4 to 6 mm in diameter. Inflorescences showy, laxly paniculate, many-flowered, inclusive of the peduncles, 16 to 35 cm long, glabrous. Ovary twisted. Flowers fleshy, 3.5 to 4.5 cm across. Lateral sepals elliptic-obovate, obtuse, 1.6 to 1.8 cm long, 9 to 11 cm wide, somewhat asymmetric. Dorsal sepal, obovate-oblong, rounded at the apex, 1.6 to 2.1 cm long, 7 to 9 mm wide. Petals spatulate, more or less falcate, rounded at the apex, 1.5 to 1.8 cm long, 7.5 to 9 mm wide above. Labellum trilobed, fleshy, shortly saccate-spurred at the base, 1.6 to 2 cm long, densely pubescent on both surfaces especially on the inner surface; lateral lobes erect and connate with the column, short, rounded-triangular, 1.5 to 2 mm high; middle lobe much larger than the lateral lobes, subquadrate-pandurate, recurved at the apex, retuse at the tip, 1 to 1.3 cm long, 8 to 9 mm wide at the broadest portion near the base, with a prominent longitudinal keel on the upper surface; spur shortly conical, obtuse, 4 to 5

mm long. Within the saccate base of the labellum (between the lateral lobes) there is a small, ovate, abruptly acuminate, deeply concave ligule, about 5 mm long. Column short, stout, 7 to 8 mm long, densely and minutely pubescent, on each side at the apex with upcurved falcate stelidia which are 3 to 3.5 mm long. Pollinia 4, united in pairs, unequal.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Bur. Sci. 84716 Quisumbing*, June 22, 1932.

The living plants were originally collected on limestone rocks and on branches of trees in Quezon National Park, Tayabas Province, Luzon.

The flowers are fragrant, and remain open for about eight weeks. Sepals and petals marguerite yellow barred and spotted with Hay's russet or madder brown, pale lumiere green at the tips; lateral lobes of the labellum white outside, primuline yellow inside spotted with vinaceous rufous, middle lobe barium yellow spotted with vinaceous-rufous; ligule between the lateral lobes at the base white; keel of labellum and column white; spur marguerite yellow; arms of the column pompeian red; anthers amber yellow.

This species is now reported from the Philippines for the first time. It differs from *T. ionosma* and *T. luzonensis* in the form of the lip.

ILLUSTRATIONS

Plate 1

Fig. 1. *Dendrobium anosmum* Lindl. var. *Dearei* (Rolfe) Ames and Quis. comb. nov., front view of flower, × 1.

2. *Dendrobium Schuetzei* Rolfe, front view of flower, × 1 (circa).
3. *Dendrobium anosmum* Lindl. var. *Huttonii* (Reichb. f.) Ames and Quis. comb. nov., × 1.
4. *Dendrobium cerinum* Reichb. f., front view of flower, × 1.
5. *Dendrobium cerinum* Reichb. f., side view of flower, × 1.
6. *Dendrobium Phillipsii* Ames and Quis. sp. nov., front view of flower, × 1 (circa).
7. *Dendrobium Phillipsii* Ames and Quis. sp. nov., side view of flower, × 1 (circa).

Plate 2

Fig. 1. *Bulbophyllum Lobbii* Lindl., front view of flower, × 1 (circa).

2. *Aërides Lawrenciae* Reichb. f. var. *Fortichii* Ames and Quis. var. nov., front view of flower, × 1 (circa).
3. *Phalaenopsis Mariae* Burbidge var. *alba* Ames and Quis. var. nov., front view of flower, × 1.
4. *Phalaenopsis Mariae* Burbidge var. *alba* Ames and Quis. var. nov., side view of flower, × 1.
5. *Aërides Lawrenciae* Reichb. f. var. *punctata* Ames and Quis. var. nov., front view of flower, × 1 (circa).
6. *Aërides Lawrenciae* Reichb. f. var. *punctata* Ames and Quis. var. nov., side view of flower, × 1 (circa).
7. *Renanthera elongata* Lindl., front view of flower, × 4 (circa).
8. *Vanda Merrillii* Ames var. *Rotorii* Ames and Quis. var. nov., front view of flower, × 1.
9. *Trichoglottis Guibertii* (Linden and Reichb. f.) Ames and Quis. comb. nov., front view of flower, × 1.
10. *Trichoglottis Guibertii* (Linden and Reichb. f.) Ames and Quis. comb. nov., side view of flower, × 1.

Plate 3

Dendrobium cerinum Reichb. f.: *1*, dorsal sepal, × 1.5; *2*, petal, × 1.5; *3*, lateral sepal, side view of column, pedicellate ovary, and spur, × 1.5; *4*, labellum from above (expanded), × 1.5; *5*, side view of labellum (natural position), × 1.5; *6*, front view of column, × 1.5; *7*, anther from above, × 3; *8*, anther from below, × 3; *9–10*, pollinia, × 6.

Dendrobium Phillipsii Ames and Quis. sp. nov.: *11*, dorsal sepal, × 1 (circa); *12*, petal, × 1 (circa); *13*, lateral sepal, × 1 (circa); *14*, labellum from above (expanded), × 1 (circa); *15*, side view of ovary and column, × 2.5 (circa); *16*, front view of column, × 2.5 (circa); *17*, anther from above, × 4.5 (circa); *18*, anther from below, × 4.5 (circa); *19*, pollinia much enlarged.

Dendrobium Schuetzei Rolfe: *20*, dorsal sepal, × 0.5 (circa); *21*, lateral sepal, × 0.5 (circa); *22*, petal, × 0.5 (circa); *23*, side view of ovary, column, and labellum (natural position), × 1 (circa); *24*, labellum from above (expanded), × 0.5 (circa); *25*, front view of column, × 1 (circa); *26*, anther from above, × 2.5 (circa); *27*, anther from below, × 2.5 (circa).

PLATE 4

Bulbophyllum Lobbii Lindl.: *1*, dorsal sepal, × 0.5 (circa); *2*, petal, × 0.5 (circa); *3*, lateral sepal, × 0.5 (circa); *4*, front view of column and labellum (natural position), × 0.5 (circa); *5*, side view of ovary, column, and labellum (natural position), × 0.5 (circa); *6*, labellum from above (natural position), × 2 (circa); *7*, anther from above, very much enlarged; *8*, anther from below, very much enlarged.

Phalaenopsis Mariae Burbidge var. *alba* Ames and Quis. var. nov.: *9*, dorsal sepal, × 1 (circa); *10*, petal, × 1 (circa); *11*, lateral sepal, × 1 (circa); *12*, side view of column and labellum (natural position), × 2 (circa); *13*, labellum from above (expanded), × 2 (circa); *14*, front view of column and labellum (natural position), × 2 (circa); *15*, anther from above, × 6 (circa); *16*, anther from below, × 6 (circa); *17*, pollinia, × 6 (circa).

Renanthera elongata Lindl.: *18*, dorsal sepal, × 2.5 (circa); *19*, petal, × 2.5 (circa); *20*, lateral sepal, × 2.5 (circa); *21*, column and labellum from above, (natural position), × 3.5 (circa); *22*, side view of ovary, column, and labellum (natural position), × 3.5 (circa); *23*, anther from above, × 10 (circa); *24*, anther from below, × 10 (circa); *25*, pollinia, × 10 (circa).

Trichoglottis Guibertii (Linden and Reichb. f.) Ames and Quis. comb. nov.: *26*, dorsal sepal, × 3 (circa); *27*, lateral sepal, × 3 (circa); *28*, petal, × 3 (circa); *29*, side view of column and labellum (natural position), × 3 (circa); *30*, front view of column, × 3 (circa); *31*, column and labellum from above (natural position) × 3 (circa); *32*, labellum from above (expanded), × 3 (circa); *33*, anther from above, very much enlarged; *34*, anther from below, very much enlarged; *35*, pollinia, very much enlarged.

PLATE 5

Dendrobium anosmum Lindl. var. *Dearei* (Rolfe) Ames and Quis. comb. nov., habit, very much reduced.

PLATE 6

FIG. 1. *Dendrobium Phillipsii* Ames and Quis. sp. nov., flowers, approximately natural size.

2. *Dendrobium Schuetzei* Rolfe, habit, very much reduced.

PLATE 7

FIG. 1. *Bulbophyllum Lobbii* Lindl., habit, much reduced.
2. *Phalaenopsis Mariae* Burbidge var. *alba* Ames and Quis. var. nov., habit, very much reduced.

PLATE 8

Renanthera elongata Lindl., habit of the plant, very much reduced.

PLATE 9

FIG. 1. *Vanda Merrillii* Ames and Quis. var. *Rotorii* Ames and Quis. var. nov., habit, very much reduced.
2. *Dendrobium cerinum* Reichb. f., habit, very much reduced.

PLATE 10

Trichoglottis Guibertii (Linden and Reichb. f.) Ames and Quis. comb. nov., habit, very much reduced.

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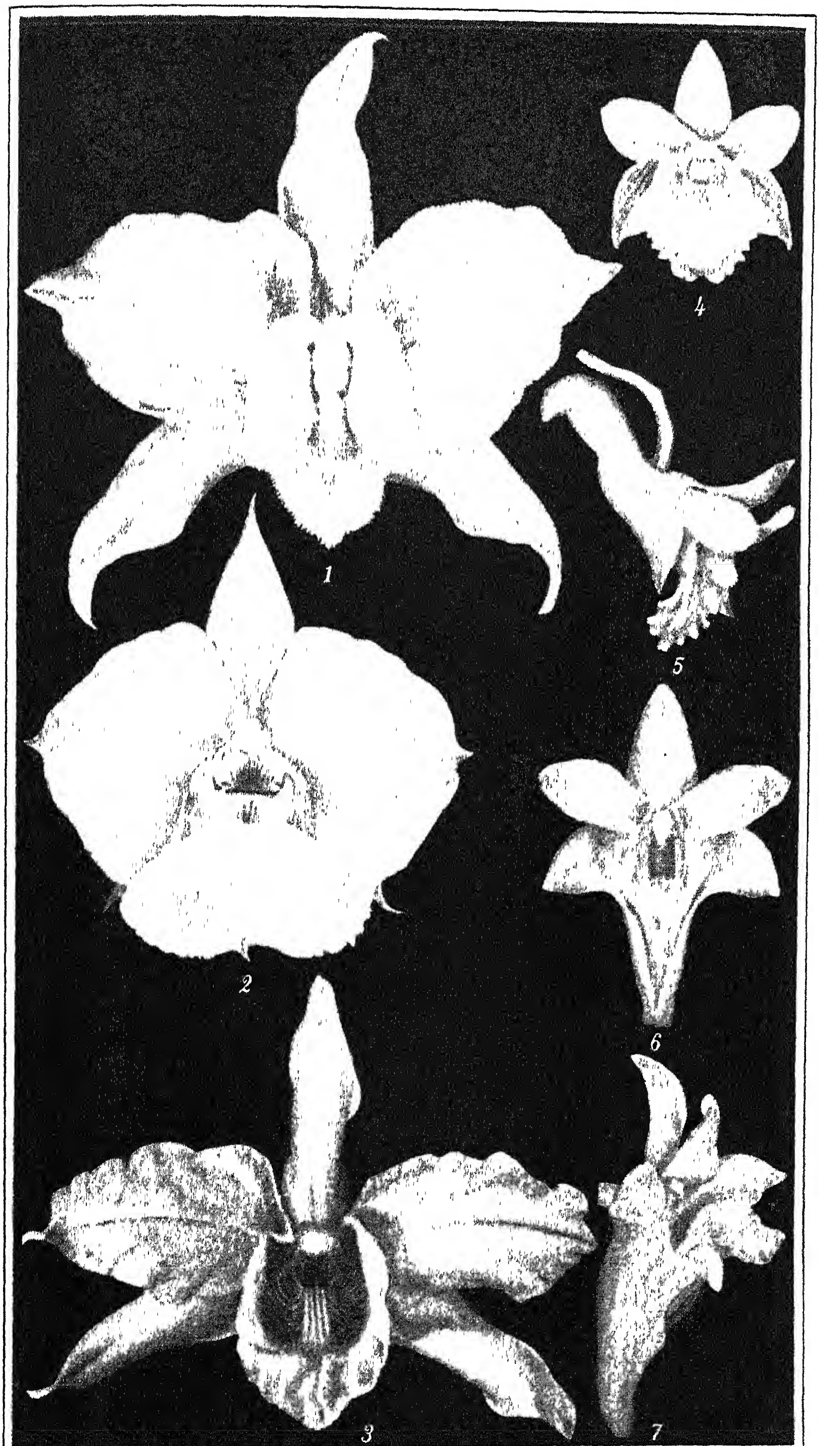
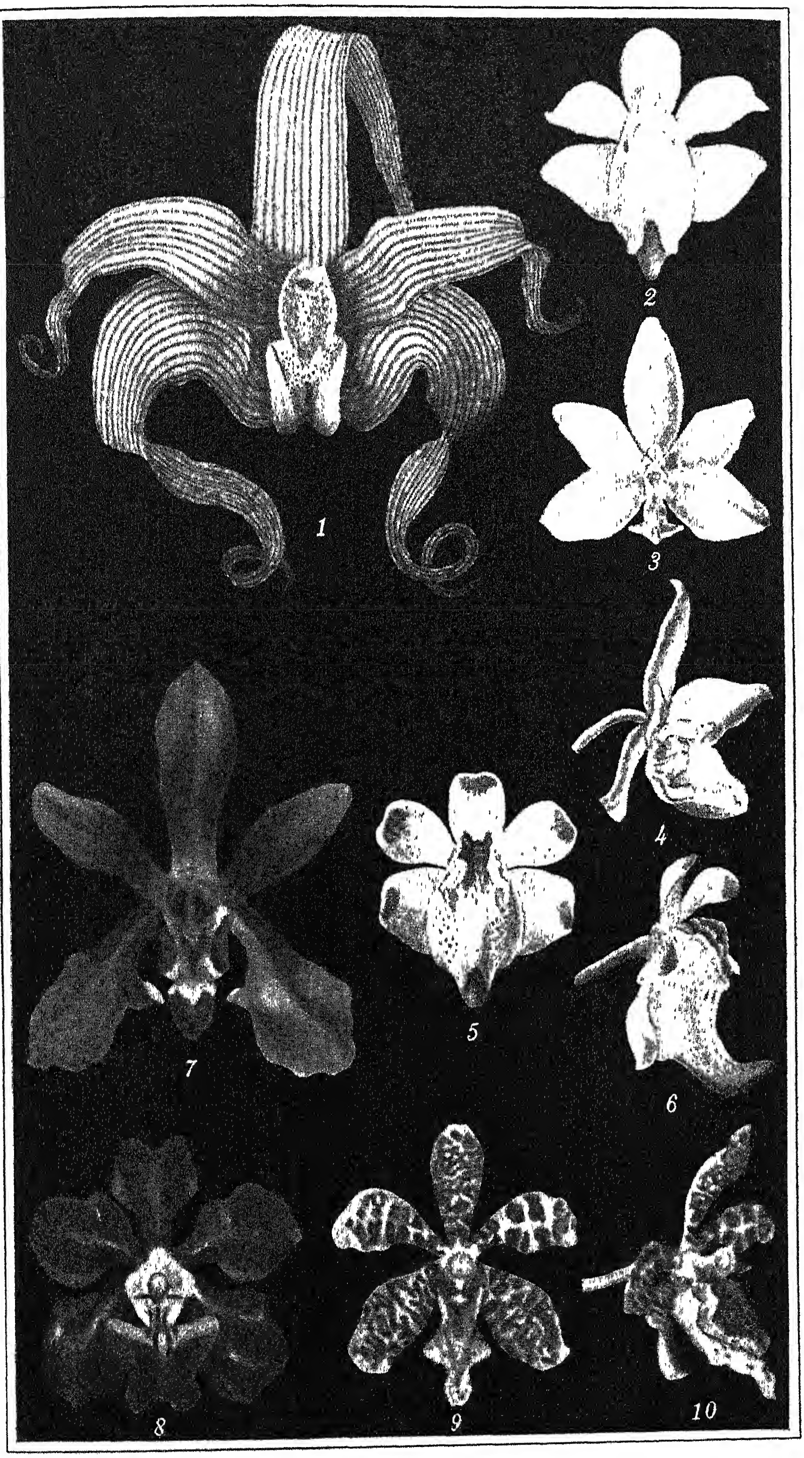


PLATE 1.



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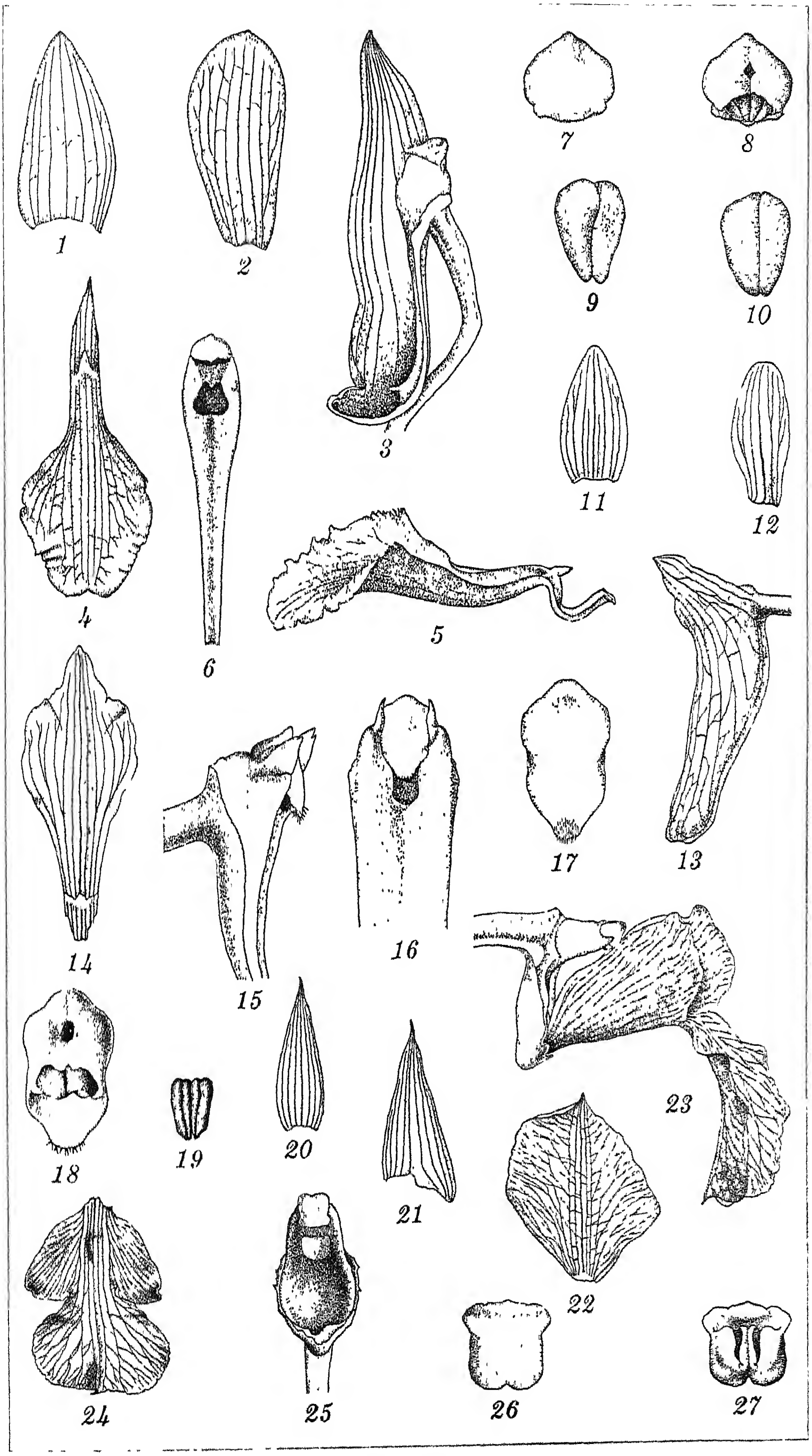

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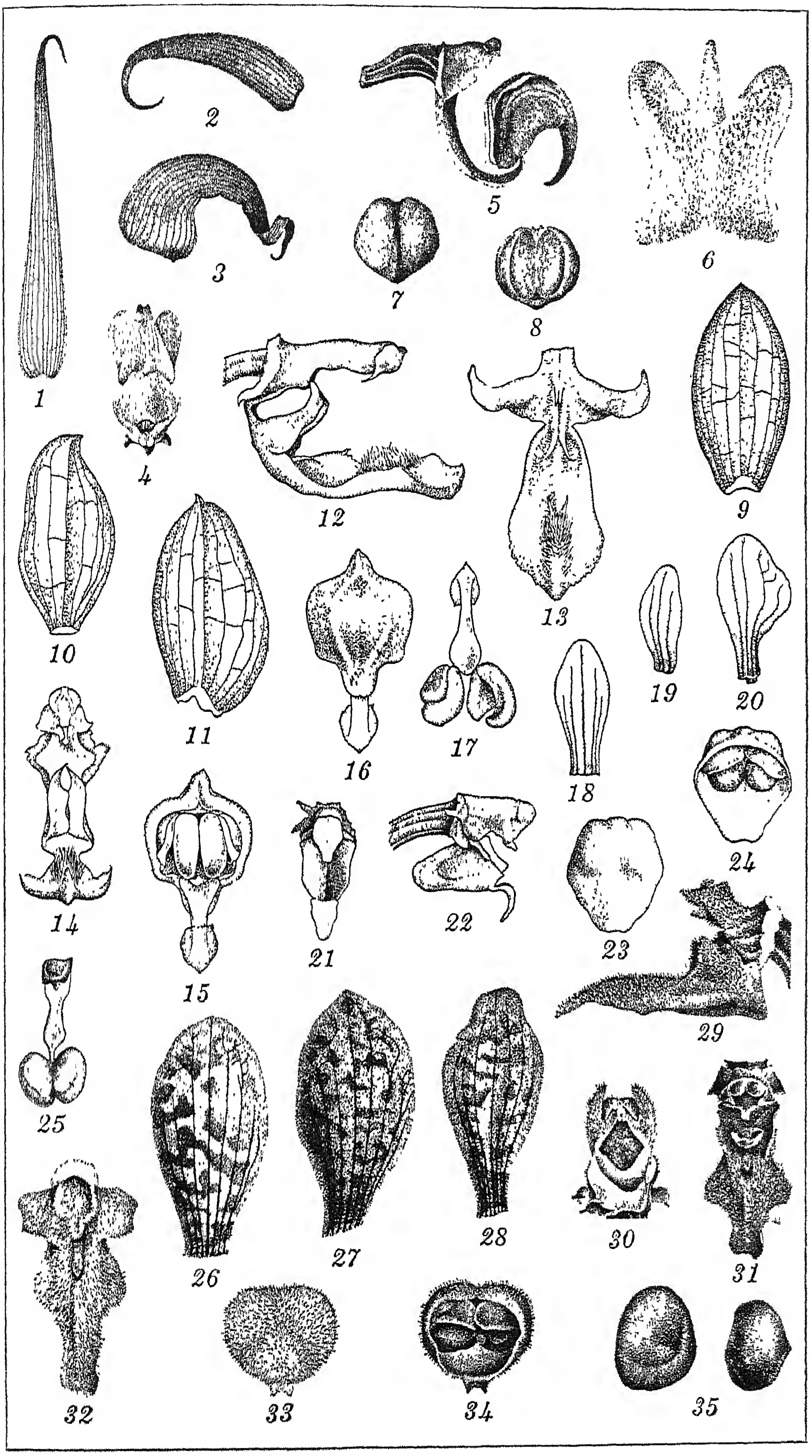
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PLATE 4.

PLATE 5.

PLATE 6.

PLATE 7.

PLATE 8.

PLATE 9.

PLATE 10.

ADDITIONAL FERNS OF KINABALU

By E. B. Copeland

Of the Department of Agriculture and Commerce, Manila

TEN PLATES

Christensen and Holttum have just published [1] a most valuable paper on the ferns of Mount Kinabalu, listing earlier collections, those by Mr. Holttum and collectors sent by him, and those of Mr. and Mrs. Clemens up to August, 1933. The Clemens expedition closed its work there in January, 1934. At Mrs. Clemens's request, Mr. Holttum being in England and identifications being urgently needed to make possible the distribution of the collections, I have undertaken to name the ferns collected during their last four months in the field. The number of additions made in this period is sufficient evidence that this mountain is by no means yet fully explored. These additions, with the Christensen and Holttum list, raise the number of Kinabalu ferns to 437 species.

The new and locally new species, and a few others inviting comment, follow.

CHRISTENSENIA AESCULIFOLIA (Blume) Maxon.

Above Kinitaki River, on wet hill, altitude 4,500 feet, *Clemens 50410*. Apparently new to Borneo. The same large form is in Java and Mindanao. A smaller one in Mindanao and the central Philippines is sometimes distinguished as *C. cumingiana*.

CYATHEA SUBBIPINNATA Copeland sp. nov. Plate 1.

Trunco, ut videtur, 3 ad 4 cm crasso, verosimiliter humile, apice stipiti conforme paleis immerso; stipite 25 ad 30 cm longo, paleis confertis castaneis pallide marginatis minute atrocastaneo-ciliatis deorsum 12 mm longis, 3 mm latis apiculatis utroque latere stipitis expansis insigniter ornato; fronde 60 cm longa, 20 cm lata subbipinnata, rhachi deorsum paleis decrescentibus ornata, sursum setulosa; pinnis infimis deflexis, brevi-stipitulatis, 10 cm longis, medio 23 mm latis, basi pinnata pinnulis saepius

[1] The ferns of Mount Kinabalu, Gardens' Bull. 7 (1934) 191–234, pls. 51–62.

1 libera et 2 adnatis, alibi pinnatifidis; pinnis medialibus sessilibus, 10 cm longis, 18 mm latis, acutis, costis glabrescentibus, segmentis falcato-rotundatis, 5 mm latis, nudis; venulis 6- vel 7-paribus, una basiscopica subapicale plerumque furcata caeteris simplicibus; soris inframedialibus, castaneis, nudis.

BORNEO, Mount Kinabalu, Gurulau spur, "crest of ridge, altitude 6,000 feet," *Clemens 50396*.

Similar to *C. bipinnatifida* Copel. of Basilan, which has very hairy axes and pale basal scales. The group is that of *C. squamulata*, which has narrower paleae and bullate squamules. This is perhaps the bipinnatifid plant referred to by Christensen and Holttum at the bottom of page 218, but I am unable to construe the plant in hand as a small *C. squamulata* or *C. elliptica*.

I mistrust, though, that we have a better developed specimen of this species in *Clemens 40354* from Dahobang River ridge, altitude 3,500 feet. It is a tree-fern 10 feet tall with tripinnatifid fronds on long stipes, the apical part, of course, bipinnatifid. The lobes are narrower than in *C. subbipinnata* as just described, more falcate, with three or four forked veinlets on the convex side, rather acute, the venation closer, and the veinlets salient on the upper surface. These differences might be correlated with greater exposure. The paleae are somewhat paler, and the double row of them extends up the rachis almost as far as there are pinnae. It has the aspect of *C. squamulata*, but is sharply enough distinguished from this by its nakedness.

CYATHEA HOLTTUMII Copeland sp. nov. Plate 2.

C. squamulatae affinis, trunco 1.5 m alto; stipite 45 cm longo, inferne paleis fuscis lanceolatis 5 mm longis rigide appressis vestito, lateribus paleis lanceolatis apice protractis nitidis fuscis patentibus integris densissime onusto; fronde 1.8 m (teste lectore) longa, ovata, apice excepta tripinnatifida, rhachi fusca, inferne setis ferrugineis plerisque 5 mm rarius usque ad 1 cm longis vestita, alibi densissime more stipitis paleacea; pinnis infimis 25 cm longis, 8 cm latis, rhachilla inferne setosa; medialibus 45 cm longis, 13 cm latis, rhachilla inferne glabrata, sessilibus, acutis; pinnulis subsessilibus basi truncatis, 6.5 cm longis 14 mm latis, acutis, $\frac{1}{2}$ ad costas pinnatifidis, papyraceis, inferne pallidis, costis inferne paleis albidis 0.5 ad 1 mm longis ovatis et lanceolatis adspersis, lobis 3 mm latis, approximatis, oblique subacutis, costulis squamulis paucis deciduis albis vestitis; ve-

nulis ca. 5-paribus quarum 1 vel 2 infra marginem convexum furcatis; soris fere medialibus, nudis.

BORNEO, Mount Kinabalu, "ridge south of Dahobang River, altitude 3,500 feet," *Clemens 40308.*

It is noted that this and the larger plant ascribed to *C. subbipinnata* are from the same locality. This one is distinguished by nonciliate paleae, the many long setae on the nether face of the rachis, and squamules on costae and costules. These distinguish it from *C. squamulata*. I do not know *Alsophila parvifolia* Holttum, which this may be; at any rate, that specific name is not valid for it in *Cyathea.*

DRYOPTERIS DENNSTAEDTIOIDES Copeland sp. nov. Plate 3.

Species aspectu Hypolepidis punctatae soris dorsalibus stipite paleaceo: rhizomate 1 cm crasso, adscendente, basibusque stipitum paleis rufis 2 ad 4 mm longis lanceolatis apice attenuatis sat dense vestitis; stipitibus approximatis non caespitosis, 45 ad 60 cm altis 2 ad 3 mm crassis, stramineis, paleis sparsis minutis aut lanceolatis aut in fibrilla angustatis vestitis; fronde anguste ovata, 60 ad 70 cm alta, tripinnata, membranacea, rhachibus minute fibrillosis, lamina nuda; pinnis remotis, suboppositis, subsessilibus, lanceolatis, usque ad 20 cm longis et 5 cm latis, acuminatis, majoribus rhachin versus paullo angustatis; pinnulis multis, sessilibus, 2 ad 2.5 cm longis, ca. 8 mm latis, obtusis; pinnulis $^{\text{II}}$ inferioribus adnatis, superioribus confluentibus, oblongis, 2 ad 3 mm latis, apice rotundato-truncatis, inciso-serratis dentibus utroque latere saepius 3; venulis simplicibus; soris medialibus, quoad venulas dorsalibus, orbicularibus, indusiis basi lata sursum curvata adnatis margine libera lobatis, in vetustate inconspicuis.

BORNEO, Mount Kinabalu, Penibukan, "base of wall north of Pinokok Falls," altitude 7,000 feet, *Clemens 50032.* "Feels clammy."

The paleae and the sori subterminal on the veinlets compel me to regard this fern as a *Dryopteris,* but it has the aspect of *Hypolepis,* or of *Dennstaedtia,* and an indusium strongly suggestive of that group of genera. By definition, it could best be *Cystopteris,* but I do not believe that to be its affinity.

DRYOPTERIS AURITA (Hooker) Christensen.

Penibukan, on rocks in river bed, altitude 4,000 feet, *Clemens 40306.* Described from northern India, and accredited to

Formosa. The Kinabalu plant agrees with the Himalayan better than does the Formosan.

DRYOPTERIS HALLIERI (Christ) Christensen.

Dahobang River, altitude 3,000 feet, *Clemens 40478*. Described from Dutch Borneo.

STENOLEPIA TRISTIS (Blume) v. A. v. Rosenburg.

Gurulau spur, altitude 12,500 feet, *Clemens 51392*. As remarked by Christensen and Holttum, the entire frond of the Kinabalu plant is like a pinna of the typical Javan one. If it were dwarfed by the environment, I would expect it to be more coriaceous; but it is less so. Unless the tripinnate form can be found on Kinabalu, it will be better to recognize them as specifically distinct.

POLYSTICHUM CLEMENSIAE Copeland sp. nov. Plate 4.

P. kinabaluensi C. Chr. affine, majus, paleis aterrimis, scilicet autem indusiis magnis distincto; stipitibus usque ad 35 cm altis, basi densissime alibi sparsius et decidue paleis ovatis usque ad 1 cm longis apice setaceo-attenuatis nitidis atris margine rufis fimbriatis, cum minoribus angustioribus rufis commixtis vestitis; fronde usque ad 40 longa et 15 cm lata, coriacea; indusiis 1 ad 1.2 mm latis, peltatis centro nigris, alibi rufis, margine fimbriatis, haud persistentibus; aliter P. kinabaluensi simile.

BORNEO, Mount Kinabalu, Gurulau spur, altitude 12,000 feet, "upper granite lobang," *Clemens 50864*.

It is possible that this is the perfectly developed form of *P. kinabaluense;* but the very numerous specimens in hand of that species show no tendency to produce the conspicuous black paleae of *P. Clemensiae,* nor are the smaller specimens of the latter without these.

POLYSTICHUM OPPOSITUM Copeland sp. nov. Plate 5.

Species gregis P. aculeati, stipite ultra 60 cm longo, fulvo, paleis membranaceis concoloribus usque ad 18 mm longis et 6 mm latis plerisque angustioribus sursum decrescentibus apice sublaceris vestito; fronde ultrametrale, vix tripinnata, rhachi praecipue superne paleis linearibus et setiformibus crinitis ciliatis vestita; pinnis remotis, oppositis, subsessilibus, linearibus, valde serrato-attenuatis, 25 cm longis, 2.5 ad 3 cm latis, rhachilla basi dense alibi sparsius squamulis et fibrillis crinitis vestita apicem versus nudis; pinnulis subsessilibus, oblique anguste triangulari-ovatis, majoribus 18 mm longis 8 mm latis, basi basiscopica excisa integra, acroscopica acuta, rarius ibidem usque ad

costam incisa cum pinnula [n] una libera, margine alibi serrulata dentibus acutis haud aristatis; soris parvis, utroque latere costae uniseriatis, medialibus, indusiis minutis, inconspicuis.

BORNEO, Mount Kinabalu, Masilau River, altitude 9,000 feet, *Clemens s. n.*, December 26, 1933. "Jungle, wet rocks; fronds 5 feet or more, no trunk."

Related to the common Philippine mossy-forest species variously identified as *P. horizontale* Presl, *P. moluccense* (Blume) Moore, and *P. aculeatum* var. *batjanense* Christ, distinguished from these by the narrow, remote pinnae, and paler paleae. *Clemens 29053* is listed, Gardens' Bull. 7 (1934) 258, as *P. parvifolium;* as represented by the specimens in hand and so named, it is no near relative of that species, but can better be regarded as a variant of *P. oppositum.*

TECTARIA NITENS Copeland sp. nov. Plate 6.

Rhizomate suberecto, lignoso, 6 mm crasso, basibusque stipitum paleis 4 ad 5 mm longis lanceolatis attenuatis integris castaneis dense vestitis; stipitibus confertis, ca. 20 cm altis, atris, nitidis, nudis; fronde deflexa, ovata, maxima visa 18 cm longa, 12 cm lata, profunde cordata lobis basalibus interdum imbricatis, ca. $\frac{1}{3}$ ad costam inciso-lobata lobis contiguis acutis falcatis quam longis latioribus, herbacea, glabra, minutissime ciliata; venatione laxa areolis costam secus maximis; soris multis sine ordine aspersis, superficialibus, indusiis persistentibus, integris, plerisque et reniformibus et in peltatas transeuntibus, nudis.

BORNEO, Mount Kinabalu, Penibukan, "jungle side hill under cliff," *Clemens 40652.*

Related to *T. melanocaulon,* but probably always simple, and with different indusia. The local *T. Holttumii,* of the same group, is hairy.

ATHYRIUM MEGISTOPHYLLUM Copeland sp. nov. Plate 7.

Diplazium, A. atrosquamoso affine, caudice ignoto; stipite ultrametrale, castaneo, basi densissime et parte inferiore sparsius paleis nitidis castaneis anguste linearibus usque ad 4 cm longis margini angustissime nigro-cinctis ibidemque spinis minutis nigris rectis inflexisve praeditis vestito, paleis demum dejectis, cicatricibus ornato; fronde enorme, vix tripinnata, rhachi glabra, rufa; pinna mediale 90 cm longa, 25 ad 30 cm lata, pedicello 2 ad 3 cm longo; pinnulis subremotis, pedicellatis (3 mm), 15 cm longis, 3 cm latis, acuminatis, basi truncatis, tenuiter papyraceis, glabris, fere ad costas pinnatifidis sinubus inferioribus rotun-

datis; segmentis 5 mm latis, obtusis, argute serrulatis; venis ca. 10-paribus, plerisque furcatis et fructiferis; soris costularibus, brevibus, indusiis vestigialibus, laceris.

BORNEO, Mount Kinabalu, Penibukan, "foot of Kinokok River falls at great wall," altitude 5,000 feet, *Clemens 40806*. "Frond 10 feet."

Judging by the specimens received here Christensen and Holttum have included three species in *A. atrosquamosum*. *Clemens 28391* and *28410* may represent this species, although the bases of the stipes bear only basal fragments of paleae, while the type, which is no juvenile specimen, bears a mass of apparently very durable crinite, fine, shiny-black ones. *No. 27122* is not this species, and our specimen of *27951* has no more than a generic resemblance to it.

DIPLAZIUM VESTITUM Presl var. **BORNEENSE** Christensen.

Diplazium vestitum Presl var. *borneense* CHRISTENSEN, Gardens' Bull. 7 (1934) 273.

I have not seen the varietal type collected by Holttum, but the Clemens specimens cited seem to me too distinct from the Philippine species to be regarded as a variety.

ATHYRIUM CUMINGII (Presl) Milde.

Penibukan, west ridge, in jungle, altitude 5,500 feet, *Clemens 50262*. Described from Luzon, where it is not rare; reported from Celebes.

ATHYRIUM MERRILLII Copeland.

Mixed with Clemens *50733* or *50577*.

In dealing with this group, I have already noted, Philip. Journ. Sci. 38 (1929) 138, how easily conspicuous group characters blind us to distinctive specific characters within the group. It is possible that *A. porphyrorachis*, *A. Merrillii*, and *A. altum* constitute one variable species, but I am still of the opinion that they are distinct and that at least two of them occur on Kinabalu; also, that there is in Borneo still another one, undescribed, with very acute segments.

"Retaining *A. fuliginosum* in *Asplenium*, it is unnatural to place this species (*A. porphyrorachis*) in *Diplazium*,"— Gardens' Bull. 7 (1934) 280. Quite so! But why retain it (*A. fuliginosum*) in *Asplenium*? It has the paleae, indusium, and bundles in the stipe of what Christensen still calls *Diplazium*, and is now more correctly named **Athyrium fuliginosum**. *Asplenium f.*, Hooker, Spec. Fil. 3 (1860) 120. The most similar species

is *A. longissimum,* Philip. Journ. Sci. 38 (1929) 139, which is more slender and without the long pinnatifid apex. The resemblance to *Asplenium longissimum* is purely superficial.

It is obvious, as Christensen states, op. cit. 268, that there are very recognizable groups within *Athyrium,* as, following Milde, I construe the genus. It is by no means equally obvious that the group as a whole has more than one origin; and until this appears probable, or until the natural minor groups can be so defined as to constitute convenient genera, I can see no reason to modify my practice. Giving names in *Diplazium* to Oriental species already named in *Athyrium* appeals to me all the less because I believe that the genus *Diplazium,* as it might survive any natural breaking up of my genus *Athyrium,* will have no representative in this part of the world.

BLECHNUM EGREGIUM Copeland.

Penibukan, in hillside jungle, altitude 4,000 feet, *Clemens 40812.* Holttum seems to have seen and recognized this species, but it is not listed. Rather common in steep, damp places at middle altitudes, throughout the Philippines.

ITHYCAULON MOLUCCANUM (Blume) Copeland.

Penibukan, by Dahobang River, altitude 4,000 feet, *Clemens 40386.* Sumatra to Polynesia; apparently new to Borneo.

POLYPODIUM HECISTOPHYLLUM Copeland sp. nov. Plate 8, fig. 1.

Rhizomate minuto, paleis paucis ovatis hyalinis fulvis 0.6 ad 0.8 mm longis apice setiferis vestito; stipitibus paucis, caespitosis, ca. 3 mm longis; fronde 2 ad 3 cm longa, 3 mm lata, ad alam costae pinnatifida, herbacea, sparse pubescente pilis inconspicuis, costa nigra, prominente; segmentis oblique oblongis vel rhomboideis, decurrenti-connexis, apice rotundatis, majoribus saepe subbilobis, supramedialibus plerumque soriferis, monosoris, planis, vel siccitate apice reflexis; venis aut simplicibus aut rarius furcatis; sporangiis nudis.

BORNEO, Mount Kinabalu, Penibukan, "Jungle ridge, on dead limb, altitude 4,000 feet," *Clemens 40837;* also, *50880,* Gurulau spur, near camp. *No. 40962,* on dead branch, altitude 7,000 feet, is a mixture containing this and other minute ferns.

To the naked eye, this seems to be a *Calymmodon,* and it is probably a part of the material discussed by Christensen under *Polypodium consociatum,* Gardens' Bull. 7 (1934) 298. I exclude it from *Calymmodon* as much because of the nonentire segments and occasional forked veins, as because of the nonfolded fertile

segments. The resemblance seems to be a matter of parallel evolution, without real immediate affinity.

GRAMMITIS PETROPHILA Copeland sp. nov. Plate 9.

Rhizomate breve paleis brunneis lanceolatis 1.5 mm longis apice mox ob apiculam perditam truncato-rotundatis dense vestito; stipitibus congestis, 2 ad 3 cm longis, gracilibus nec debilibus, pube sordido dense velutinis; frondibus 10 ad 16 cm longis, 5 ad 7 mm latis, utrinque attenuatis apice saepe curvatis, subcoriaceis, costa inferne et margine pilis sparsis deciduis obsitis; venis bis furcatis ramo inferiore acroscopico sorifero, apicibus superne saepe glanduloso-conspicuis; soris ordinatis, medialibus, immersis, receptaculo elliptico; sporangiis nudis.

BORNEO, Mount Kinabalu, Penibukan, "on mossy rocks of Pinokok River below falls, altitude 5,500 feet," *Clemens 50133*. *No. 29061*, identified as *Polyp. fasciatum*, Gardens' Bull. 7 (1934) 293, is this species.

GRAMMITIS REINWARDTIOIDES Copeland sp. nov. Plate 10.

Rhizomate breve, paleis brunneis nitidis lanceolatis 1.5 mm longis apicibus protractis deciduis vestito; stipitibus gracillimis fasciculatis, ca. 1 cm longis, pilis pallidis usque ad 1.7 mm longis vestitis; fronde 10 ad 15 cm longa, 6 ad 9 mm lata, utrinque angustata, fusca, subcoriacea, costa et margine pilis longis ferrugineis obsitis, lamina fere glabra; venis late patentibus, furcatis, ramo acroscopico sorifero breve, altero haud ad marginem protracto; soris fere costalibus parvis, globosis (nec receptaculo elongato) superficialibus, sporangiis setiferis.

BORNEO, Mount Kinabalu, Penibukan, "epiphyte by Dahobang River, altitude 3,500 to 4,500 feet," *Clemens 40792*.

Differs from *G. Reinwardtii* in being more slender, less rigid, with longer hairs, and rather smaller sori. The veins are less conspicuous and less nearly horizontal, the acroscopic branch less extremely short. Whether or not this is the fern mentioned by Christensen, Gardens' Bull. 7 (1934) 295, as similar to *G. Reinwardtii*, I do not try to guess. It is more like the plant I distributed as *G. Jagoriana* than like that correctly so-called. The *Grammitis* species are all small and very similar in aspect; but they have still many distinguishing features, and these occur in all possible combinations. As far as is known, most of the species are quite local; and a single mountain with any rich fern flora, in this part of the world, always has a considerable number of them.

POLYPODIUM LASIOSORUM Hooker? Cf. Christensen and Holttum op. cit. 294.

Penibukan, altitude 4,000 feet, *Clemens s. n.*, January, 1933. This little fern is very distinct in appearance because of its copious long setae—up to 4 mm long, on fronds 3 mm wide and up to 6 cm long. I would deem it distinct from any Javan specimen I have seen, and from "*Grammitis pusilla γ lasiosora*" Blume and *Grammitis nana* Fée. But after writing a description of it, I find this not essentially different from Hooker's of *Polypodium lasiosorum*, made from specimens from Blume.

GRAMMITIS SETOSA Blume.

Masilao River, altitude 6,000 feet, *Clemens 51367*. The sori are rather more immersed and elongate than in Javan specimens.

GRAMMITIS CUNEIFOLIA Copeland sp. nov. Plate 8, fig. 2.

Rhizomate parvo, paleis brunneis lanceolatis apiculatis 1 ad 1.5 mm longis vestito; stipitibus fasciculatis, non articulatis, 1 ad 6 mm longis, gracilibus, pilis sparsis 0.3 mm longis ornatis; fronde lineari-oblanceolata, 5 cm longa, 2 ad 3 mm lata, obtusa, basi attenuata, subcoriacea, ubique setosa setis 0.6 mm longis aut solitariis aut subfasciculatis; venis inferioribus simplicibus superioribus furcatis ramis aequalibus; soris superficialibus globosis, setis multis protectis, confluentibus, sporangiis nudis.

BORNEO, Mount Kinabalu, Penibukan, "On dead branch, base of wall, north of Pinokok Falls," altitude 7,000 feet, *Clemens 40962, partim.*

Related to *G. Jagoriana*, but thinner, less stipitate with less conspicuously clustered hairs; sporangia naked. As Christensen correctly notes, Gardens' Bull. 7 (1934) 295, the plant I once distributed as *P. Jagorianum, Pterid, Philip. Exsic. 70*, is not at all that species.

OREOGRAMMITIS CLEMENSIAE Copeland.

As happened seventeen years before, Mrs. Clemens has collected this fern mixed with *Grammitis kinabaluensis, No. 51393.* It has been collected also by Holttum, with the comment by Christensen: "Certainly a distinct species, but the validity of the genus is very problematical,"—Gardens' Bull. 7 (1934) 292. Previously he wrote, Dansk Bot. Arkiv 6 (1929) 30, 31, "I should prefer to drop the genus and place the species in *Polypodium*," which for him includes *Grammitis*. The new material, very scanty still, shows some polypodioid sori, followed higher on the same fronds by unbroken coenosori.

The affinity to *Grammitis* is perfectly clear; that to *Scleroglossum,* suggested when the genus was published, does not exist, is only a misleading superficial resemblance. As far as affinity goes, it may well be reduced to *Grammitis*. So, with at least equal propriety, may *Nematopteris*, at least *N. interrupta*—*Polypodium pyxidiforme* v. A. v. R. *Polypodium pleurogrammoides* Ros. bridges the gap between *Grammitis* and *Scleroglossum*. The American genus *Cochlidium* has a distinct ancestry, but is equally without a distinct line of separation from polypodioid ancestors and relatives. Maxon has reduced *Xiphopteris* to *Polypodium* because there is no open gap between them and the affinity is clear. Those who reduce *Prosaptia* and *Acrosorus* to *Polypodium* have the same justification. And *Loxogramme* can be reduced to *Grammitis* almost as properly.

If affinity were the sole consideration, we would all agree on all of these reductions. It is the other criterion of the propriety of recognizing a genus which restrains me—that of convenience. Without the aberrant groups, *Polypodium* and *Grammitis* are big genera, but easy to define. Where the aberrant derived small groups are included, definition becomes too inconvenient for my taste.

SCLEROGLOSSUM INTERMEDIUM Copeland comb. nov.

Monogramma intermedia COPELAND, Philip. Journ. Sci. 1 Suppl. (1906) 255.

Gurulau, jungle spur, altitude 5,000 to 6,000 feet, *Clemens 50583, 50685*. Described from Negros. This may very well be *Taenitis simplicivenia* Cesati, but I do not see how it can be *Scleroglossum pusillum*.

ACROSORUS STREPTOPHYLLUS (Baker) Copeland comb. nov.

Polypodium streptophyllum BAKER, Journ. Bot. (1879) 42; C. CHRISTENSEN, Gardens' Bull. 7 (1934) 298.

Represented here by *Clemens 27992, 29506*, and supplementary collections. I am trusting Christensen's identification of the first of these, never having seen an authentic specimen of the species. But I cannot accept his reduction of *Acrosorus triangularis, A. exaltatus,* and *A. Frederici et Pauli* to this species. *Acrosorus exaltatus* may be a synonym of *A. triangularis*. If any other species is to be reduced to *A. streptophyllus*, it is *A. Merrillii*. This is known only by the type collection, which is more coriaceous, and with a better defined fertile portion of frond, than these Kinabalu plants. Further collection will show whether or not even these minor distinctions are constant.

I have called attention in the past to the tendency of very striking characters to make us overlook or undervalue those less conspicuous. If *Calymmodon cucullatus* and *Acrosorus streptophyllus* are retained in *Polypodium,* they appear so very peculiar there that features of size, texture, etc., are likely to be overlooked. It is only when the conspicuously peculiar features are construed as generic characters, that such features as would in general be accepted as characteristic of species command any attention.

POLYPODIUM (Better, GONIOPHLEBIUM) RAJAENSE C. Christensen.

This should not be construed as a variety of "Polypodium integriore."

ANTROPHYUM LATIFOLIUM Blume.

Penibukan, by waterfalls, altitude 5,000 to 6,000 feet, *Clemens 40294, 40963.* Known in Sarawak, but new to Kinabalu.

ILLUSTRATIONS

[All type specimens. Drawings by Borbe. Photographs by the Bureau of Science.]

PLATE 1

Cyathea subbipinnata Copeland sp. nov.: *1*, Frond, × 0.375; *2*, segment, × 3.7; *3*, palea of stipe, × 22.

PLATE 2

Cyathea Holttumii Copeland sp. nov.: *1*, Frond, × 0.35; *2*, segment, × 3.5; *3*, palea of stipe, base, × 20; *4*, palea of rachis, × 20.

PLATE 3

Dryopteris Dennstaedtioides Copeland sp. nov.: *1*, Plant, × 0.36; *2*, pinnule, × 22; *3*, sorus, × 21; *4*, palea, × 21.

PLATE 4

Polystichum Clemensiae Copeland sp. nov.: *1*, Plant, × 0.37; *2*, pinnule, × 3; *3*, sorus, × 21.5; *4*, palea, × 21.5.

PLATE 5

Polystichum oppositum Copeland sp. nov.: *1*, Frond, × 0.35; *2*, pinnule, × 2.1; *3*, palea, base, × 20.

PLATE 6

Tectaria nitens Copeland sp. nov. Type sheet, × 0.4.

PLATE 7

Athyrium megistophyllum Copeland sp. nov.: *1*, Part of stipe and frond, × 0.38; *2*, segment, × 23; *3*, sori, × 22; *4*, part of palea, × 22.

PLATE 8

FIG. 1. *Polypodium hecistophyllum* Copeland sp. nov.: *a*, Plants, × 0.57; *b*, one frond, × 2.3.

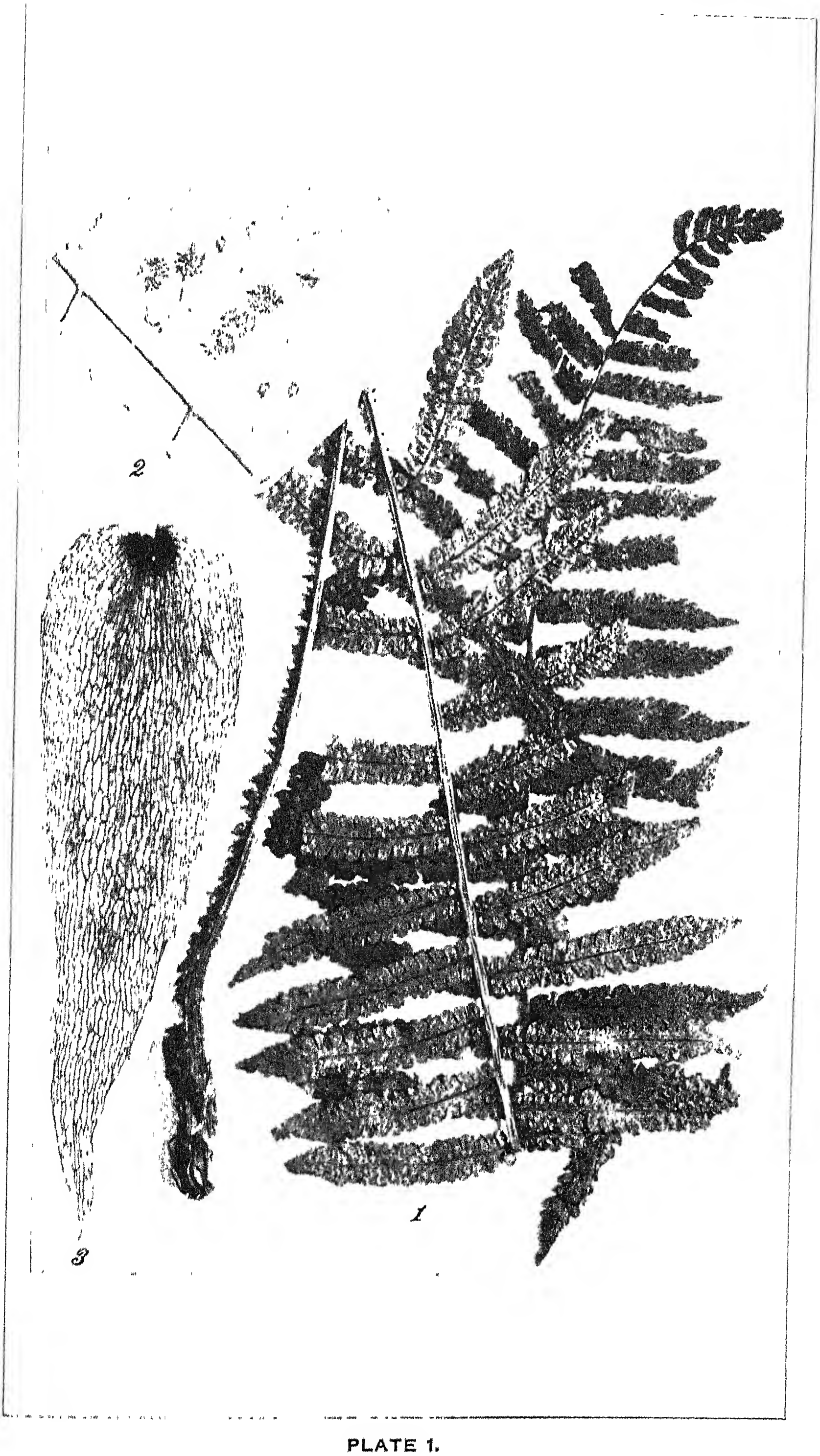
2. *Grammitis cuneifolia* Copeland sp. nov.: *a*, Plant, × 0.57; *b*, apex of frond, × 5.7; *c*, palea, × 34.

PLATE 9

Grammatis petrophila Copeland sp. nov.: *1*, Plants, × 0.41; *2*, detail of frond, × 4.1; *3*, detail of stipe, × 24; *4*, sporangium, × 31; *5*, palea, × 24.

PLATE 10

Grammatis Reinwardtioides Copeland sp. nov.: *1*, Plants, × 0.52; *2*, detail of frond, × 4.2; *3*, palea, × 30.



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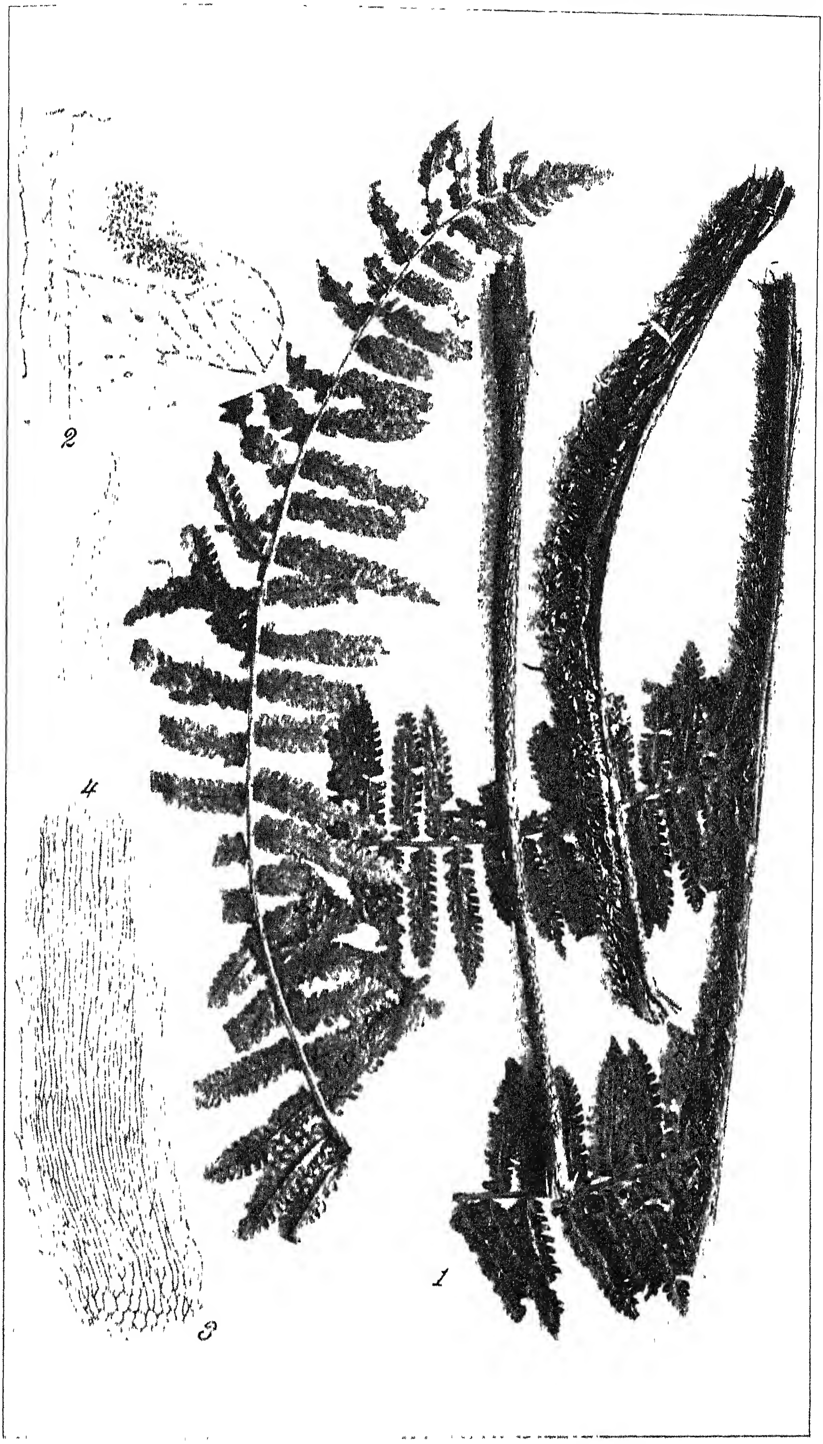

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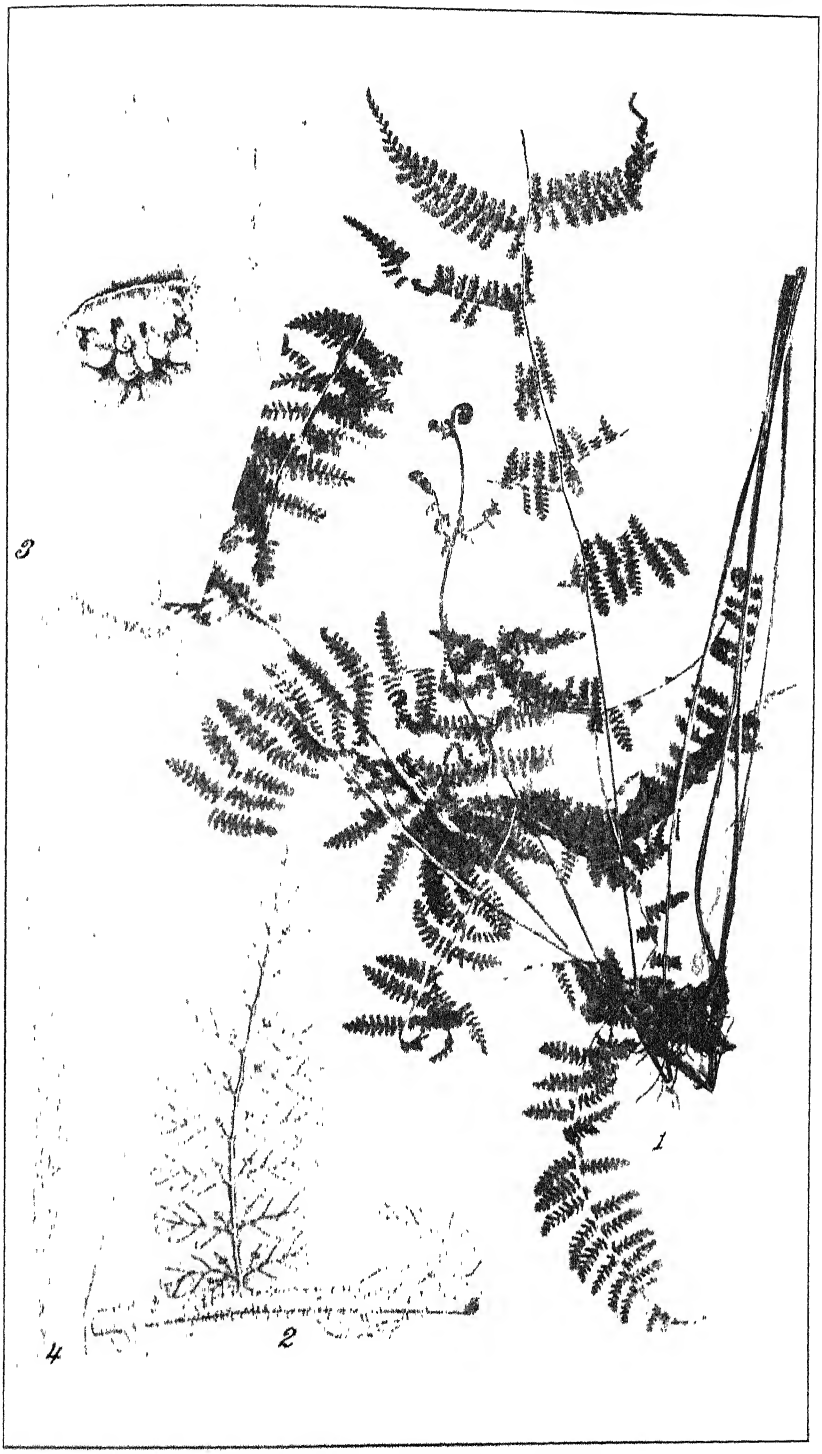
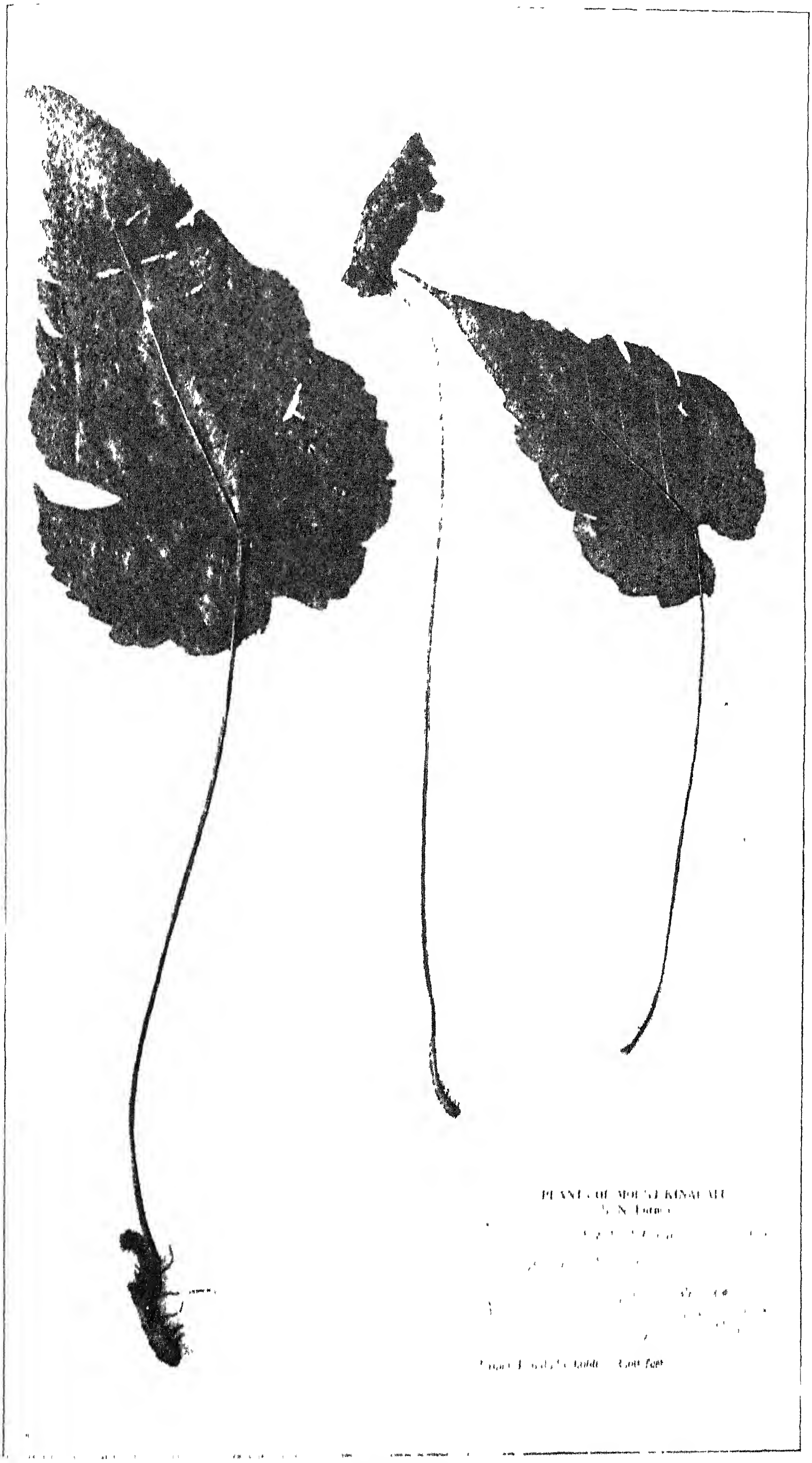


PLATE 3.

PLATE 4.

PLATE 5.



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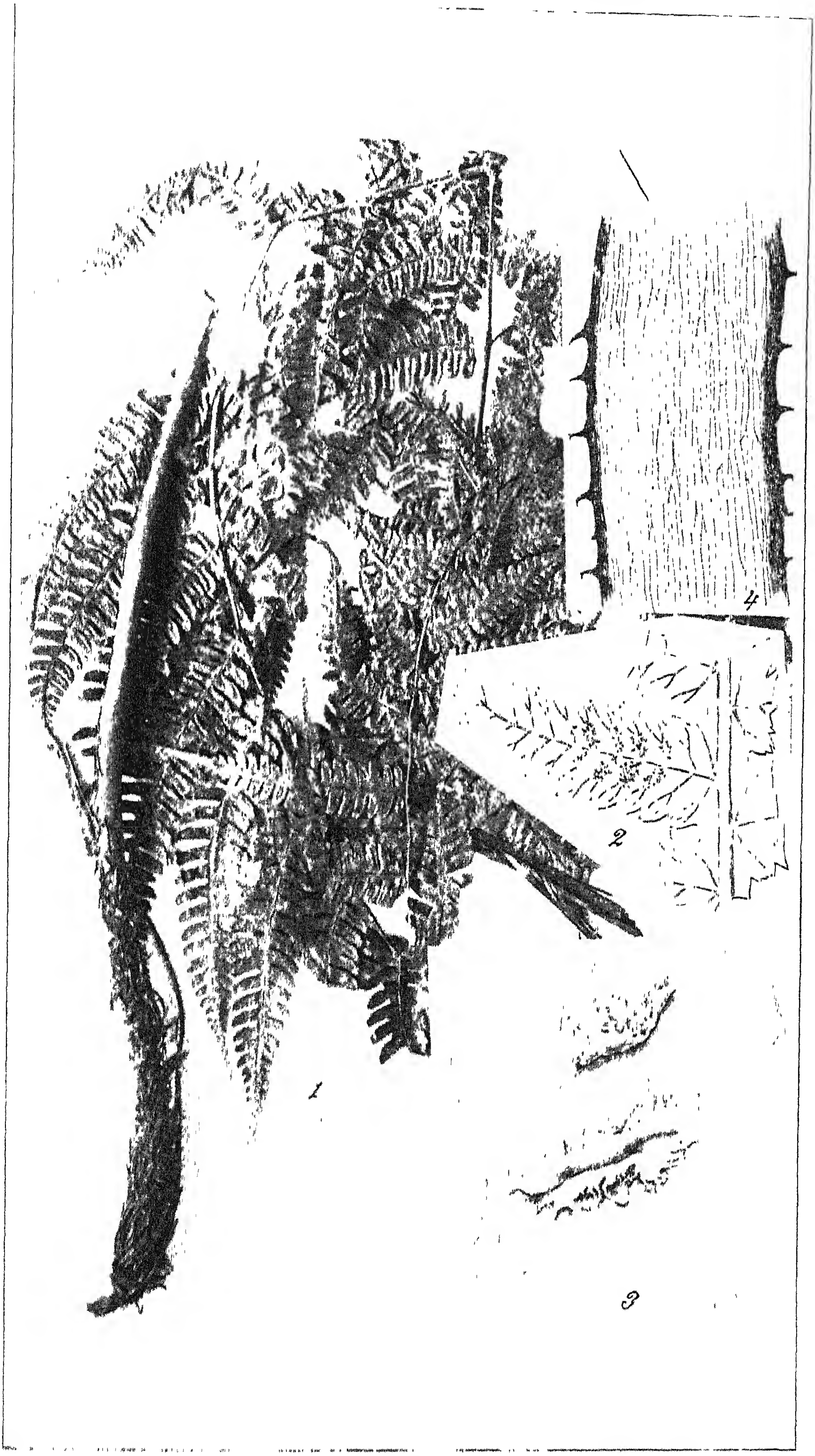

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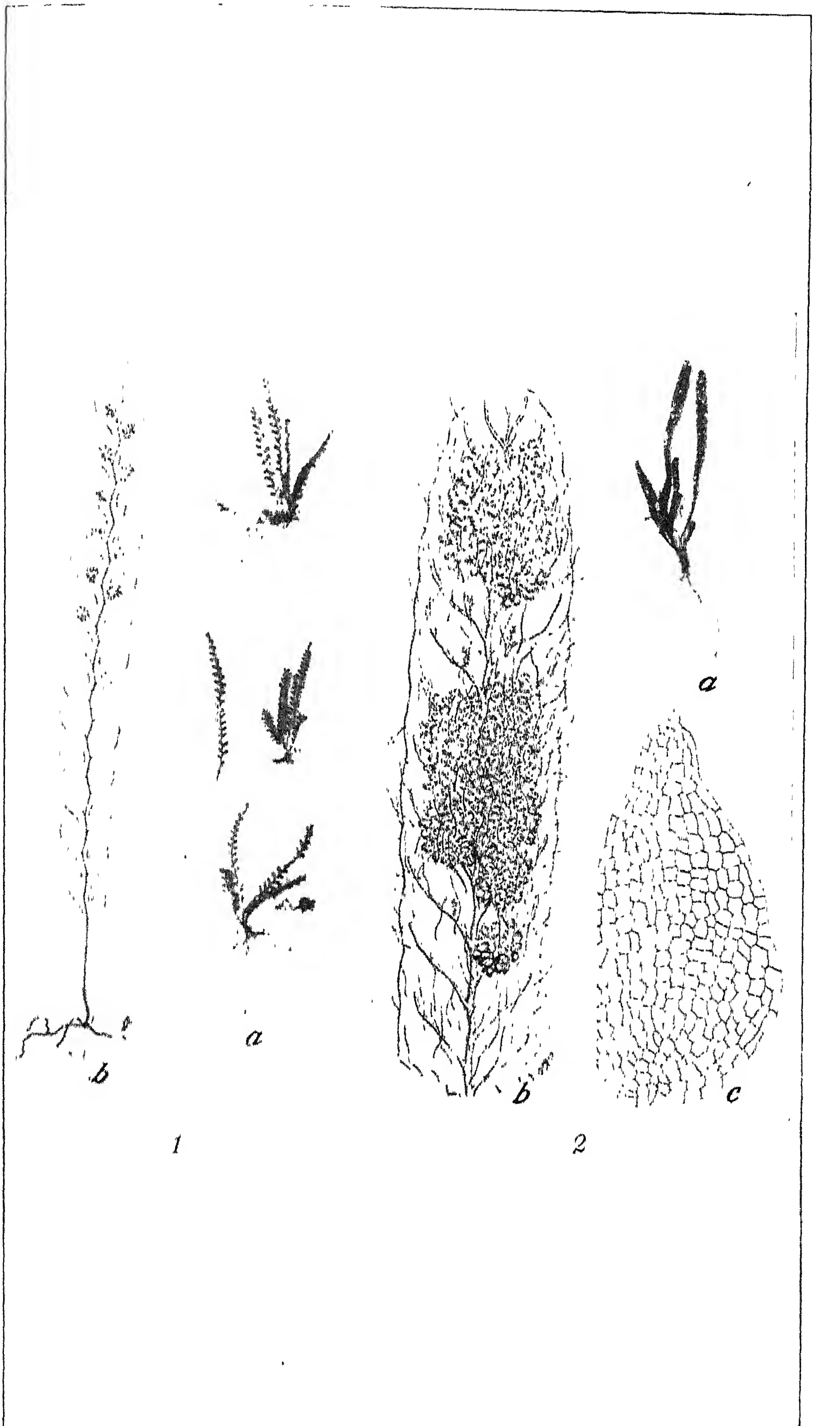

PLATE 8.

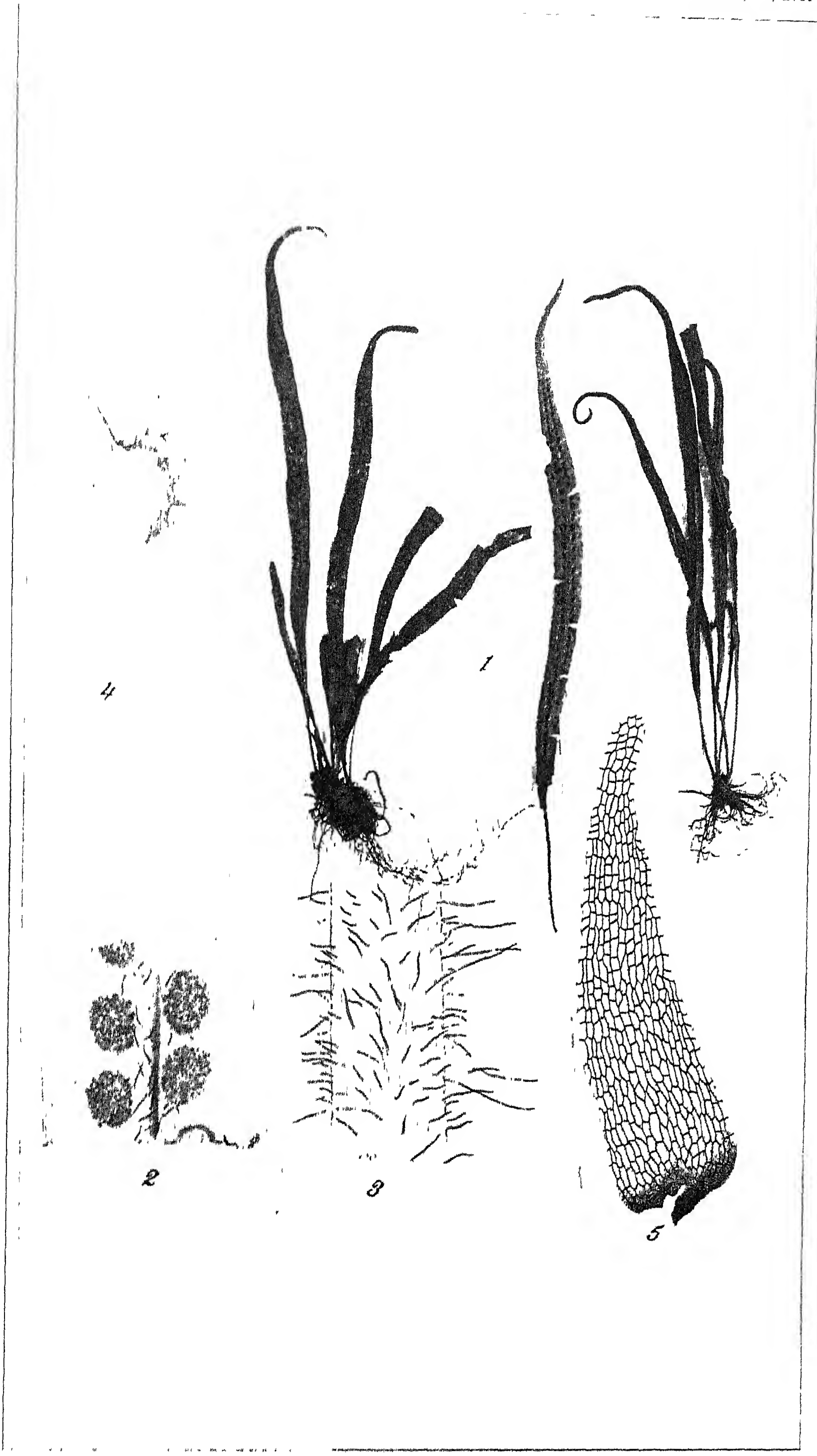

PLATE 9.

PLATE 10.

NOTES ON PHILIPPINE MOSQUITOES, I

THE ARMIGERES GROUP [1]

By F. E. Baisas

Of the Philippine Health Service, Manila

FOUR PLATES AND THREE TEXT FIGURES

The culicine mosquitoes of the Philippines have not been intensively studied. Undoubtedly a good collection from such important islands as Luzon, Mindanao, and Palawan will bring to light many interesting new forms. The main part of what is now known of Philippine culicines is the descriptions based upon specimens sent to Dr. C. S. Ludlow by the United States Army, to Dr. H. G. Dyar by Dean C. F. Baker, and by some other workers to the British Museum and elsewhere. It is regrettable that no duplicate of this material was left in the Philippines, for direct comparison of new material should be made with such type specimens.

[1] Submitted for publication October, 1934. This study was made in the laboratory of Malaria Investigations of which Dr. Paul F. Russell is chief. Malaria Investigations is jointly supported by the Bureau of Science, Manila, and the International Health Board of the Rockefeller Foundation.

The material upon which the discussions are based was collected partly by me while I was stationed in the malaria field laboratory of the Bureau of Health at Tungcong Manga, San Jose, Bulacan Province, Luzon, and on anopheline collecting trips to Mindanao, Palawan, and other places, for Malaria Investigations; partly by the staff of the Bureau of Health malaria field laboratory who submitted to me for identification caught-wild mosquitoes; partly by Mr. D. Santiago and Mr. F. Guinto, of Malaria Investigations; and partly by the staff of the United States Army Medical Department Research Board, who sent mosquitoes to Malaria Investigations for determination. The mounting of adults and the dissection of male terminalia and other structures were done exclusively by Mrs. I. V. Ramos, of Malaria Investigations. All the drawings were traced by me with the aid of a camera lucida and inked by Mr. E. Enriquez and Mr. W. Garcia, artists of Malaria Investigations.

To all these people and particularly to the Director of Health, to Dr. C. Manalang, and to Dr. A. Ejercito, of the Bureau of Health, and to Dr. Paul F. Russell, under whom I have been assigned the last four years, I am greatly indebted.

Seven species are included in this paper, three of which are new. They are the following:

Armigeres (*Armigeres*) *ejercitoi* sp. nov.
Armigeres (*Armigeres*) *kuchingensis* Edwards, 1915.
Armigeres (*Armigeres*) *manalangi* sp. nov.
Armigeres (*Armigeres*) *russelli* sp. nov.
Armigeres (*Leicesteria*) *degitatus* Edwards, 1914.
Armigeres (*Leicesteria*) *flavus* Leicester, 1908.
Armigeres (*Leicesteria*) *magnus* Theobald, 1908.

The nomenclature employed in the following descriptions is in accordance with the latest published works of Edwards (1932), Christophers (1933), and Barraud (1934). Text figs.

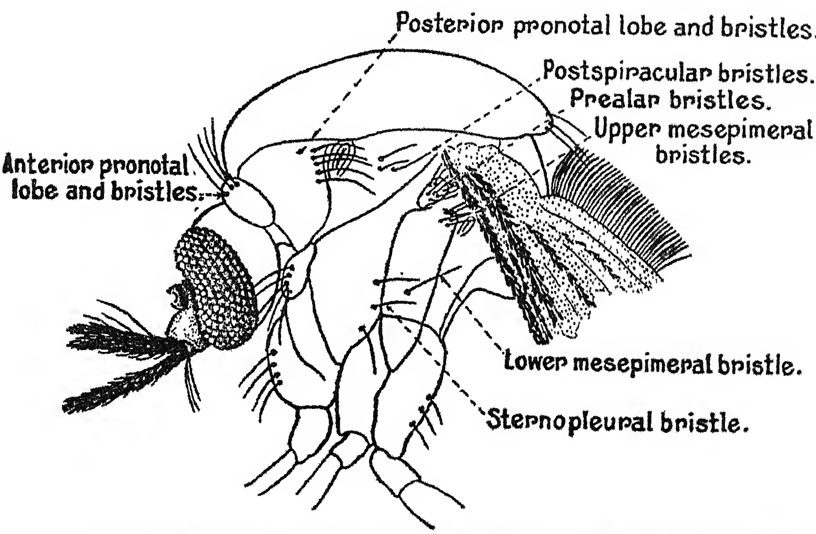

FIG. 1. *Armigeres ejercitoi* sp. nov., pleural side of thorax; from a camera-lucida drawing.

1 (pleural side of thorax) and 2 (male terminalia) show some of the more important parts.

ARMIGERES (ARMIGERES) EJERCITOI sp. nov.

Types.—Male (lot R28–4), and female (lot R28–3) with their corresponding larval skins; cotypes, 6 males and 7 females with their corresponding larval skins; and 10 males and 6 females without larval skins are all in the Philippine Bureau of Health collections at Manila. Collected by F. E. Baisas from Kolambugan, Lanao, Mindanao, March 21, 1934. Larva breeds in fairly good number in tree holes. Habits of adults unknown.

Adult (*male and female*).—Head clothed with dark brown flat scales, a few white ones on vertex; some upright forked

scales on nape. A border of creamy scales to eyes, somewhat broadening along sides. Clypeus dark, bare. Antennæ normal; tori with broad flat scales all around. Proboscis dark, shorter than front femur. Palpi dark, about one-fourth the length of proboscis in female, and longer by about the length of the apical segment in male. Thorax: Mesonotum covered with dark brown scales; a broad border of white scales along the margin from anterior side to above wing roots. Præscutellar area with a median patch of white scales forming a continuous white line with pale scales on middle of midscutellar lobe. Dark scales cover edges of middle lobe and the whole of two lateral lobes of scutellum. Anterior pronotal lobe covered with white scales. Pleura and coxæ with wide patches of broad, flat, silvery scales. Postspiracular bristles usually two, sometimes four. White scales but no black ones on postspiracular area. One lower mesepimeral bristle. Wings dark-scaled. Legs dark except undersides of fore and midfemora where there is a longitudinal line of white scales extending from bases to apices of segments. Hind femur extensively pale at about basal two-thirds or more underneath. Fore tarsal claws of female normal. Hind tibia as long as middle tibia. Abdominal tergites dark except VIII where there is a median basal pale patch or band. White lateral patches hardly visible dorsally on most of the segments; sternites extensively pale, particularly I and II. Apical dark patches or bands on III to VI; VII usually dark basally, white apically, entirely dark in some individuals.

Male terminalia (*Plate 1, figs. 1, 3 to 5, 7, and 8*).—Lobes of tergite IX not very prominent, bearing about nine spines each. The median thickening of sternite IX sometimes imperfectly fused with main chitinous part, and bearing about eight spines besides microtrichia. Coxite short and broad. Basal lobe and its spines represented by six or seven clublike spines, besides many smaller ones along inner border. Style rather short, bearing on its slightly expanded apex ten or eleven strong teeth.

The form of the style of the male terminalia resembles that of *Leicesteria.* Other characters, however, are distinctly of the subgenus *Armigeres* aside from the peculiar basal lobe. The shortness of the female palp, the presence of postspiracular bristles, and of white scales but no black ones on the postspiracular area, and the lower mesepimeral bristle, are characteristic of the subgenus *Armigeres.*

ARMIGERES (ARMIGERES) KUCHINGENSIS Edwards, 1915.

A widely distributed species; found in various places, both sylvan and urban, in Luzon and Mindanao; breeds in bamboo joints and tree holes.

Adult (male and female).—Head covered with broad flat scales, some scattered white ones on vertex, and upright scales on nape; a border of white to eyes, broadening at sides; remaining parts blackish. Clypeus black, bare. Antennal tori with broad flat scales. Proboscis dark, about as long as front femur. Palpi dark, less than one-third the length of proboscis in female, longer by about one-half the length of the ultimate segment in male. Thorax: Mesonotum covered with narrow dark brown scales, a border of pale ones around the edges from anterior margin to wing roots. The area behind the anterior pronotal lobe is extensively white and joins the white border line. Præscutellar area with a patch of pale scales at middle, forming a continuous line with white scales on middle of scutellar midlobe. Lateral lobes as well as the sides of midlobe of scutellum covered with dark scales. Anterior and posterior pronotal lobes covered with white scales. Postspiracular bristles present; white scales, but no black ones, on postspiracular area; one lower mesepimeral bristle. Extensive patches of white scales on pleura and coxæ. Wings dark-scaled. Legs dark except undersides of femora, which are whitish. Abdominal tergites covered with dark brown scales; tergite VIII with a wide, median, pale basal patch or band. White lateral patches on most of the segments, visible dorsally on posterior segments. Sternites white up to VI; VII dark basally, white apically. In some there are black apical patches on sternites III to VII. The white patches on the lateral side of tergites are continuations of the sternal white parts.

Male terminalia (Plate 3, figs. 1, 3, 5, and 7).—Lobes of tergite IX not very prominent, each bearing about ten spines. Sternite IX with median thickening bearing about seven spines arranged roughly in a single row. Coxite long and broad with numerous long spines. Basal lobe of coxite with three or four curved spines pointing toward the center of the coxite. Style with a row of strong teeth aligned on more than the apical half of the inner side; tip reaches basal lobe when pressed against coxite.

A single specimen sent to us from Mount Kinabalu, at about 4,000 feet elevation, Borneo, is very much like *A. kuchingensis*

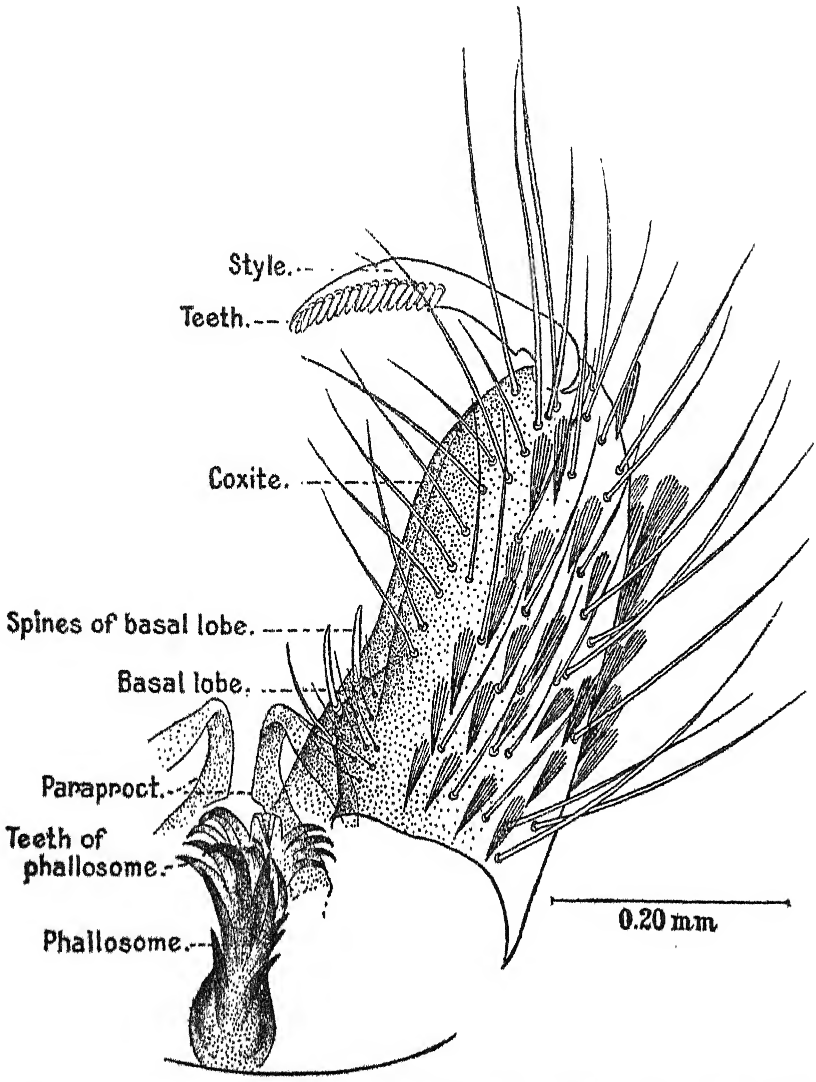

FIG. 2. *Armigeres* sp., from Borneo, one side of male terminalia; from a camera-lucida drawing.

in male genitalic characters (text fig. 2). The style, however, is shorter and the phallosome differs markedly from that of true *kuchingensis*. The specimen is not in good condition, and it is difficult to say exactly what it is.

Armigeres kuchingensis was previously known locally as *obturbans* Walker, 1860. In a personal communication Doctor Barraud called my attention to this matter.

ARMIGERES (ARMIGERES) RUSSELLI sp. nov.

Types.—Male (lot SR 1–x), and female (lot SR 1–y); cotypes 12 males and 5 females; all in the Philippine Bureau of Health collections, Manila. Collected by Mr. D. Santiago at Masiit, Calauan, Laguna, August 17, 1930. Known also from Mindanao (F. E. Baisas, 1932). Larva breeds in good numbers in tree holes, bamboo joints, and in axils of fallen areca-palm leaves.

Adult (*male and female*).—Head clothed with broad flat scales, some white ones on vertex; a few upright, forked, black and white scales at nape. A border of white scales to eyes, broadening at sides. Clypeus dark, clothed with broad, flat, creamy scales along edges; middle bare. Antennæ normal; tori with flat white scales along inner sides. Proboscis dark, about as long as front femur. Palpi dark, about one-sixth the length of proboscis in female, longer by about one-half the length of the ultimate segment in male. Thorax: Mesonotum covered with dark brown scales; a patch of white scales along the border behind the head and above the wing roots; these white patches sometimes imperfectly connected by scattered white scales between them. Præscutellar area with a median white patch connected with the line of broad, flat, white scales on midscutellar lobe. Black scales on sides of midlobe, and dark and pale ones on lateral lobes of scutellum. Anterior pronotal lobe clothed with pale scales. Extensive patches of broad, flat, silvery scales on pleura and coxæ. No spiracular bristle; postspiracular bristles present. A patch of white scales, but no black ones, covers the postspiracular area. One lower mesepimeral bristle in all specimens except one, which has two. Wings dark-scaled. Legs dark except undersides of femora, which are white. Fore tarsal claws of female normal. Hind tibia as long as middle tibia. Abdominal tergites clothed with dark brown scales; a basal median patch or band of pale scales on VIII. Lateral white patches not visible dorsally. Sternites mainly white.

Male terminalia (*Plate 2, figs. 2, 4, and 7, and text fig. 3, a.*)—Lobes of tergite IX prominent, each bearing about fifteen spines toward apex. Sternite IX with median thickening bearing about fifteen spines, besides two or three small flat scales. Basal lobe

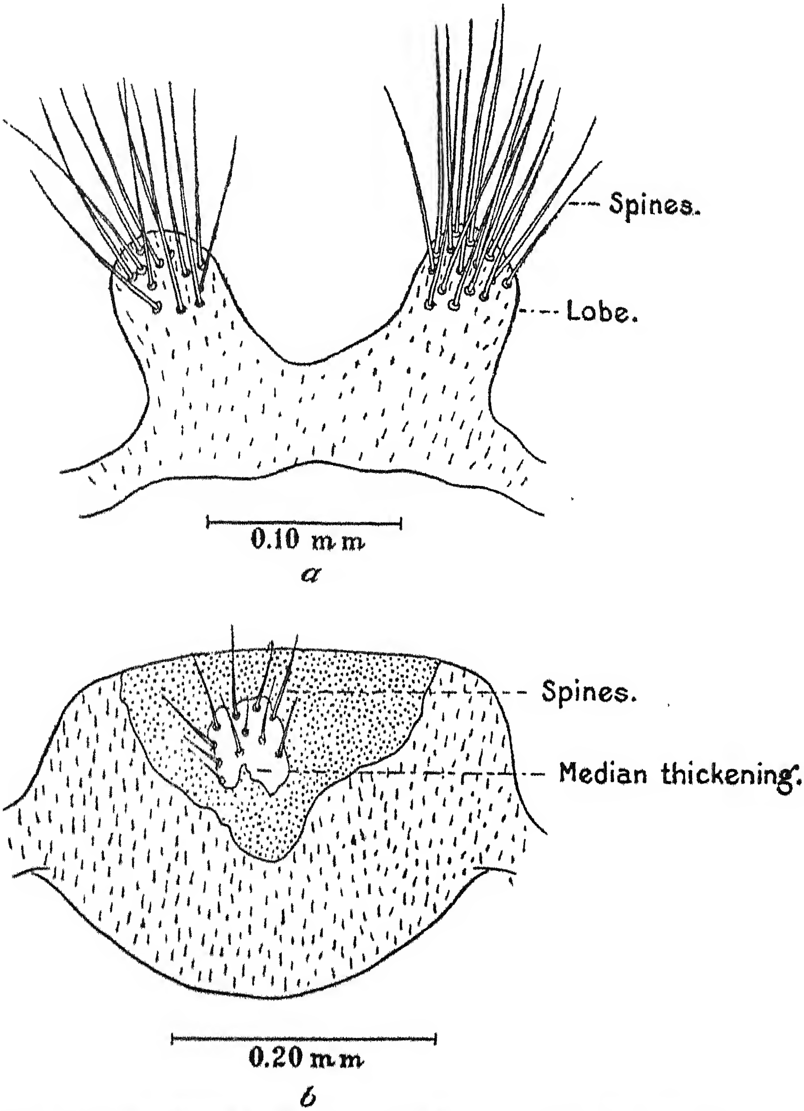

FIG. 3. *a*, *Armigeres russelli* sp. nov., ninth tergite; *b*, *Armigeres manalangi* sp. nov., ninth sternite; from camera-lucida drawings.

of coxite with six or seven spines, the one towards inner edge much longer than the rest. Coxite fairly long and broad. Style bears about fifteen strong teeth towards the apex, the uppermost longest.

This species closely resembles *Armigeres* (*Armigeres*) *malayi* Theobald (1901 and 1903), as given by Edwards (1917), and *Neosquamomyia breinli* Taylor (1914), but the male terminalia

differs in certain respects from the illustration given by Edwards (1917). The style of *russelli* is stouter, and its teeth are much longer. The spines of the basal lobe of the coxite are not arranged in one row, while the phallosome differs remarkably from that of any other *Armigeres* and does not seem to be like the one figured by Edwards.

ARMIGERES (ARMIGERES) MANALANGI sp. nov.

Types.—Male (lot PHS 1–x), and female (lot PHS 1–y) in the collection of the Philippine Health Service, Manila. Collected by Dr. C. Manalang at Tungcong Manga, San Jose, Bulacan, November, 1929. Larva breeds in small numbers in bamboo holes. Two males and three females bred out from larvæ collected from a bamboo joint by Mr. D. Santiago, at Mabacan, Calauan, Laguna, November, 1931. Habits of adults unknown.

Adult (male and female).—Head clothed with dark scales, some white ones on the middle of vertex; nape with upright forked scales. A border of creamy scales to eyes, broadening at sides; lateral white patches at about middle on either side. Clypeus black, nude. Antennæ dark; tori with broad, flat, creamy scales. Proboscis dark, slightly shorter than front femur. Palpi dark, a little over one-fifth the length of proboscis in female, and longer by about the length of the terminal segment in male. Thorax: Mesonotum covered with dark brown scales, a narrow border of white ones from anterior margin to wing roots. Præscutellar area with a patch of curved white, and broad white scales, forming a continuous line with white scales on middle of midscutellar lobe. Lateral lobes of scutellum with a mixture of dark and pale scales. Anterior pronotal lobe white-scaled. No spiracular bristle; postspiracular bristles present. A patch of white scales, but no black ones, covers postspiracular area; one or two lower mesepimeral bristles. Pleura and coxæ extensively covered with patches of silvery scales. Wings dark-scaled. Legs dark except the undersides of femora, which are white. Fore tarsal claws of female normal. Hind tibia as long as midtibia. Abdominal tergites with brownish black scales mixed with a few scattered pale scales. Lateral white patches on posterior segments visible dorsally. Sternites mainly pale.

Male terminalia (Plate 2, figs. 1, 3, 5, and 6).—Lobes of tergite IX fairly prominent, the spines of which are arranged along the inner borders. Sternite IX with a median thickening, bear-

ing seven to fifteen spines and numerous microtrichia. Basal lobe of coxite with three blunt-ended straight spines, little differing in length; also hairs of various sizes. Coxite fairly long and broad. Style very much expanded apically [similar to that of Edward's *Dunnius* (1930)], bearing over twenty strong teeth, besides numerous hairs of various lengths. Phallosome with about eleven teeth on either side.

ARMIGERES (LEICESTERIA) DEGITATUS Edwards, 1914.

Found by a number of workers in various places in Luzon. Larva breeds in small numbers in tree holes and bamboo joints.

Adult (male and female).—Head clothed with broad, flat, dark scales; a few white ones at middle of vertex; upright scales at nape. A border of pale scales to eyes; two lateral, broad, pale patches on either side. Clypeus dark, bare. Antennæ normal; tori with broad flat scales on the inner sides. Proboscis dark, about as long as front femur. Palpi dark, about two-thirds the length of proboscis in female, longer by about one-half the length of last segment in male. Thorax: Covered with dark brown scales, a border of broad pale scales around margin from anterior edge to wing roots; a pale patch at middle of præscutellar area contiguous with the line of broad, flat, pale scales at middle of midscutellar lobe. Rest of scutellum dark-scaled. Anterior pronotal lobe white-scaled. No postspiracular bristle; black scales anteriorly and white ones posteriorly occupy postspiracular area. No lower mesepimeral bristle. Pleura and coxæ with extensive patches of broad, flat, white scales. Wings dark-scaled. Legs dark except undersides of femora, which are white. Abdominal tergites dark brown; VIII with a pale basal patch or band. Lateral white patches visible dorsally on III to VII. Sternites extensively white with dark apices.

Male terminalia (Plate 1, figs. 2 and 6).—Tergite IX with prominent lobes, each bearing apically about twelve long spines. Coxite long, fairly broad. Basal lobe of coxite with about six sharp-pointed spines arranged roughly in double rows. Style with five strong spines at its apex.

ARMIGERES (LEICESTERIA) FLAVUS Leicester, 1908.

Males and females bred out from larvæ collected from tree hole at Lilio, Laguna, Luzon, by Mr. D. Santiago.

Adult (male and female).—Head clothed with broad, flat, pale scales; some upright scales at nape. Two dark patches on either side. Clypeus dark, bare. Antennæ normal, tori orange

with broad flat scales on inner sides. Proboscis dark, slightly shorter than front femur. Palpi dark, less than one-half the length of proboscis in female, longer by about the length of the ultimate segment and pale-ringed at the joints in male. Thorax: Mesonotum clothed with brownish scales, a border of pale scales from anterior margin to wing roots. Præscutellar area dark. Scutellar lobes pale-scaled. Anterior pronotal lobe dark above, pale below. Postspiracular area covered with black scales anteriorly and a white patch posteriorly. One lower mesepimeral bristle. Extensive patches of broad, flat, white scales on pleura and coxæ. Postnotum with one to four very minute hairs on posterior part, but no scales in specimens examined. Wings dark-scaled, except the humeral and the prehumeral areas of the costa, which are white. Legs dark brown; fore and mid-femora white beneath; hind femora white on the anterior and posterior surfaces; tibiæ pale basally; hind tibiæ with pale apical ring; mid and fore tibiæ with pale patches beneath. Tarsi with basal pale rings on first two or three segments, more conspicuous on the hind tarsi than on the others. Abdominal tergites dark; II to VI with pale, median, apical patches. Pale lateral patches visible dorsally only on VIII, which is otherwise entirely dark above, sometimes lateral pale patches also visible on VI and VII dorsally. Sternites pale.

Male terminalia (*Plate 4, figs. 1 and 4*).—Tergite IX with many strong spines at the apices of lobes. Coxite fairly long and broad; basal lobe with two or three blunt-ended spines. Style bears five teeth at its apex and a few scales on the outer border.

ARMIGERES (LEICESTERIA) MAGNUS Theobald, 1908.

A widespread species; found in several places in Luzon and Mindanao. Larva breeds in tree holes and bamboo joints. Female bites freely during the day in bamboo grooves.

Adult (*male and female*).—Head covered with broad flat scales; a patch of white towards nape; a pair of pale patches on either side laterally. A narrow rim of pale scales to eyes; remaining area dark. Clypeus dark, nude. Antennæ normal; tori dark with broad flat scales. Proboscis dark, about as long as front femur. Palpi dark, about two-thirds the length of proboscis in female, longer by about the length of last segment in male. Thorax: Mesonotum covered with dark brown scales; a

border of broad white scales around the margin from anterior side to wing roots. A patch of white scales at middle of præscutellar area. Midscutellar lobe with white scales posteriorly, dark ones anteriorly. Lateral lobes mainly dark-scaled, with a few pale scales posteriorly. Anterior pronotal lobe white-scaled. Postspiracular area occupied by a patch of dark scales anteriorly, and a patch of white scales posteriorly. No lower mesepimeral bristle. Pleura and coxæ extensively covered with patches of white scales. Wings dark-scaled. Legs with the femora pale underneath and at the apices; tibiæ pale at the apices; tarsi usually with pale basal patches on segments 1 to 3. Abdominal tergites dark brown with pale basal patches excepting I. Lateral white patches visible dorsally on III to VII. Sternites extensively pale with dark apices, and yellow basal patches, the yellow extending to the lateral and dorsal sides, forming complete basal bands on the posterior segments.

Male terminalia (Plate 4, figs. 2, 3, 5, and 6).—Lobes of tergite IX not prominent, each bearing about six to ten spines. Sternite IX without a median thickening. Coxite broad and fairly long. Basal lobe of coxite with three or four pointed spines. Style with about ten teeth at its somewhat expanded tip; there may be some scales on the outer border.

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ILLUSTRATIONS

Plate 1. Male Terminalia

Fig. 1. *Armigeres ejercitoi* sp. nov., coxite and style.
2. *Armigeres degitatus* Edwards, coxite and style.
3. *Armigeres ejercitoi* sp. nov., one side of phallosome.
4. *Armigeres ejercitoi* sp. nov., tip of phallosome, dorsal view.
5. *Armigeres ejercitoi* sp. nov., one lobe of ninth tergite.
6. *Armigeres degitatus* Edwards, one lobe of ninth tergite.

Figs. 7 and 8. *Armigeres ejercitoi* sp. nov., ninth sternites.

Plate 2. Male Terminalia

Fig. 1. *Armigeres manalangi* sp. nov., coxite and style.
2. *Armigeres russelli* sp. nov., coxite and style.
3. *Armigeres manalangi* sp. nov., phallosome.
4. *Armigeres russelli* sp. nov., one side of phallosome.
5. *Armigeres manalangi* sp. nov., one lobe of ninth tergite.
6. *Armigeres manalangi* sp. nov., ninth sternite.
7. *Armigeres russelli* sp. nov., ninth sternite.

Plate 3. Male Terminalia

Fig. 1. *Armigeres kuchingensis* Edwards, coxite and style.
2. *Armigeres obturbans* Walker, of India, coxite and style.
3. *Armigeres kuchingensis* Edwards, one side of phallosome.
4. *Armigeres obturbans* Walker, of India, one side of phallosome.
5. *Armigeres kuchingensis* Edwards, one lobe of ninth tergite.
6. *Armigeres obturbans* Walker, of India, one lobe of ninth tergite.
7. *Armigeres kuchingensis* Edwards, ninth sternite.
8. *Armigeres obturbans* Walker, of India, ninth sternite.

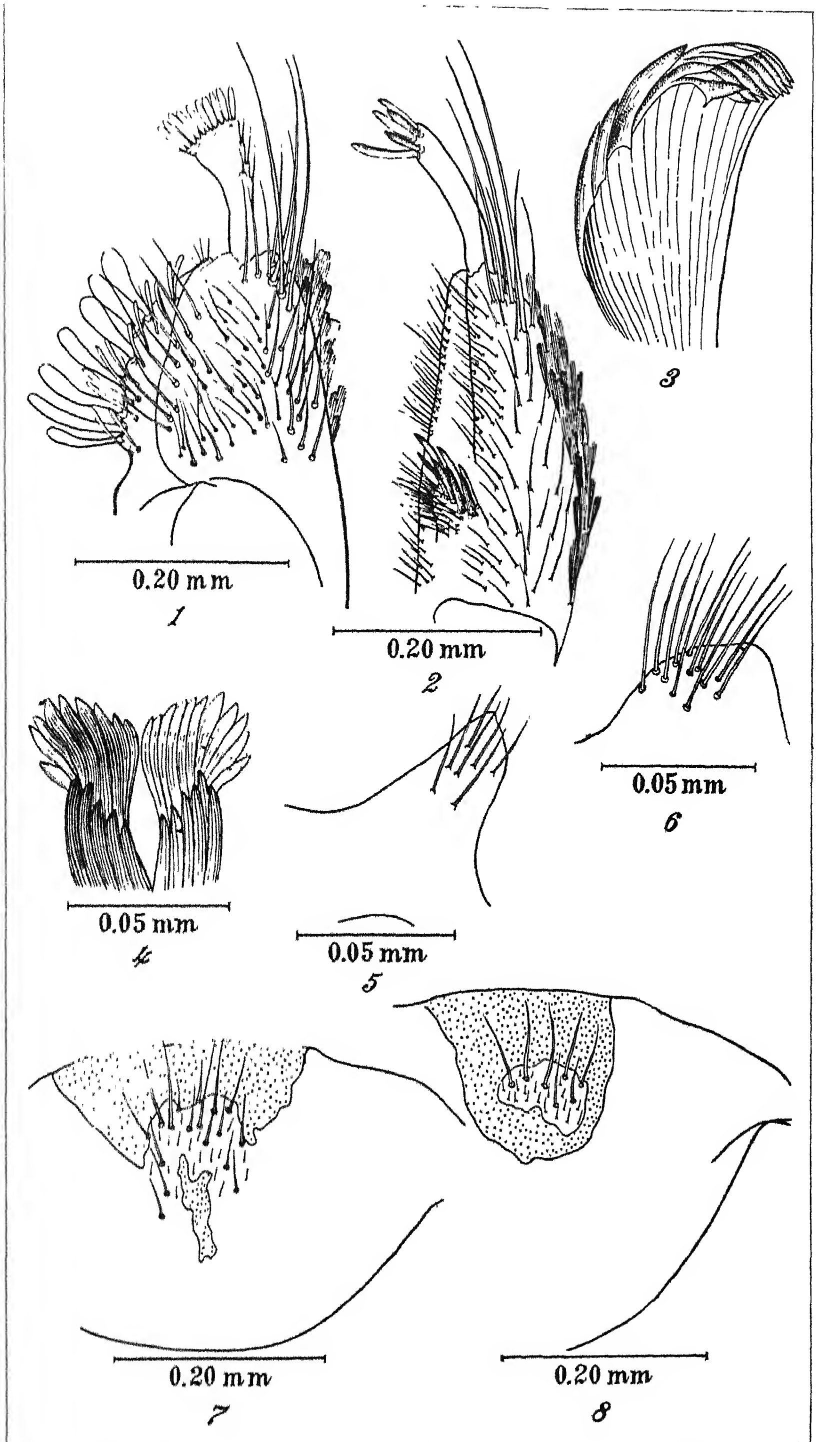
Plate 4. Male Terminalia

Fig. 1. *Armigeres flavus* Leicester, coxite and style.
2. *Armigeres magnus* Theobald, coxite and style.
3. *Armigeres magnus* Theobald, one side of phallosome.
4. *Armigeres flavus* Leicester, one lobe of ninth tergite.
5. *Armigeres magnus* Theobald, ninth tergite.
6. *Armigeres magnus* Theobald, ninth sternite.

TEXT FIGURES

[From camera-lucida drawings.]

Fig. 1. *Armigeres ejercitoi* sp. nov., pleural side of thorax.
2. *Armigeres* sp., from Borneo, one side of male terminalia.
3. *a*, *Armigeres russelli* sp. nov., ninth tergite; *b*, *Armigeres manalangi* sp. nov., ninth sternite.



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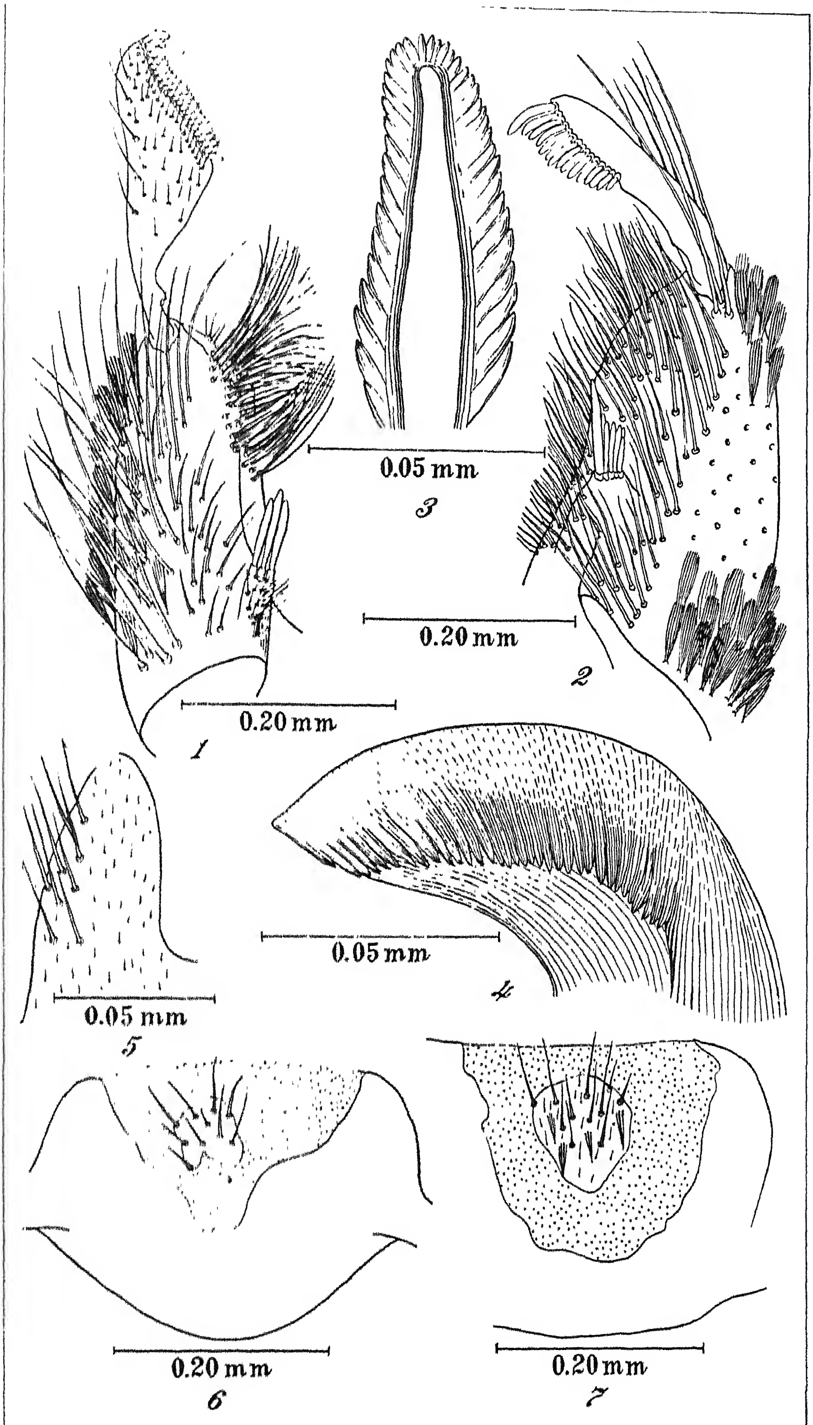


PLATE 2.

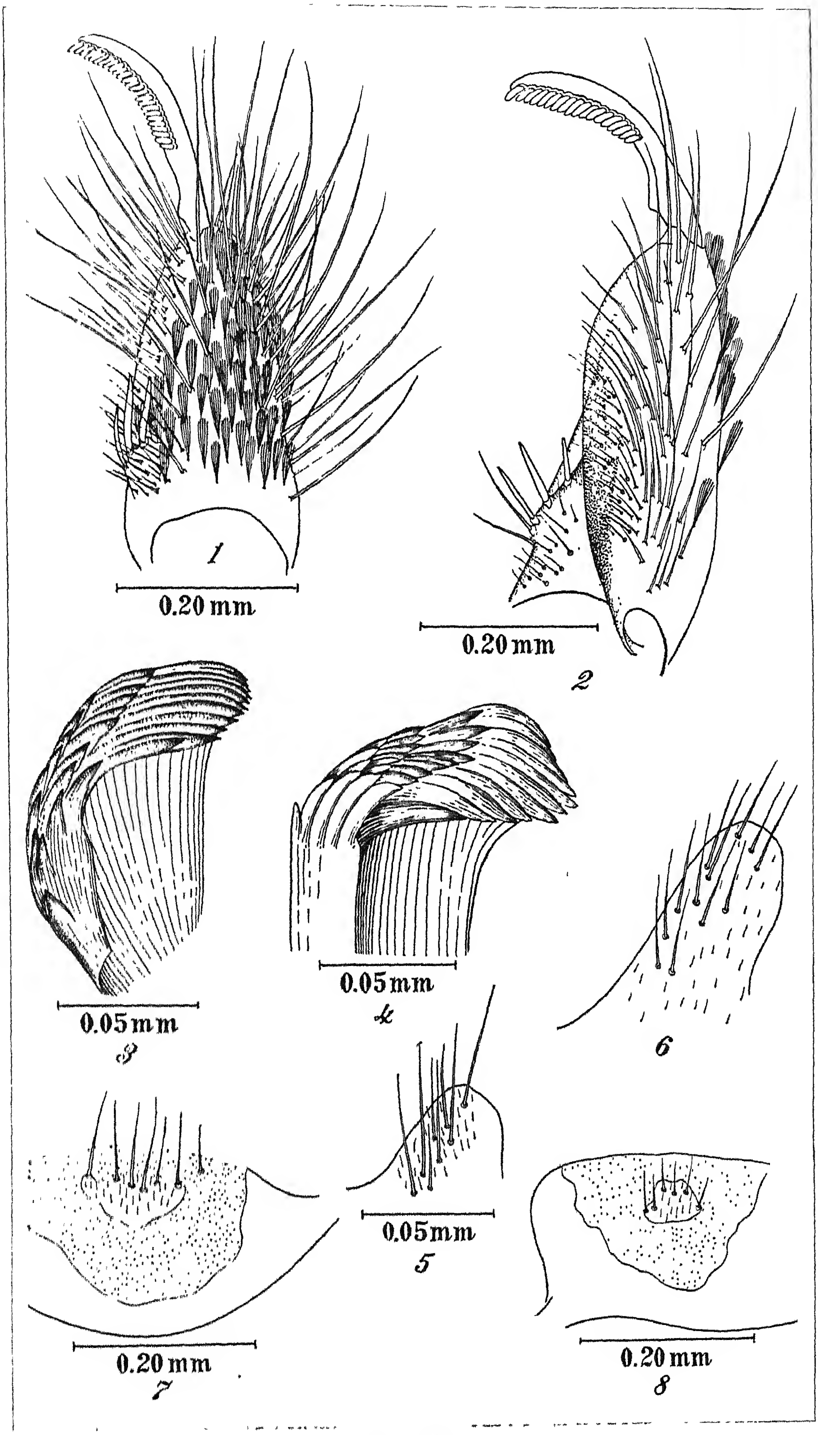


PLATE 3.

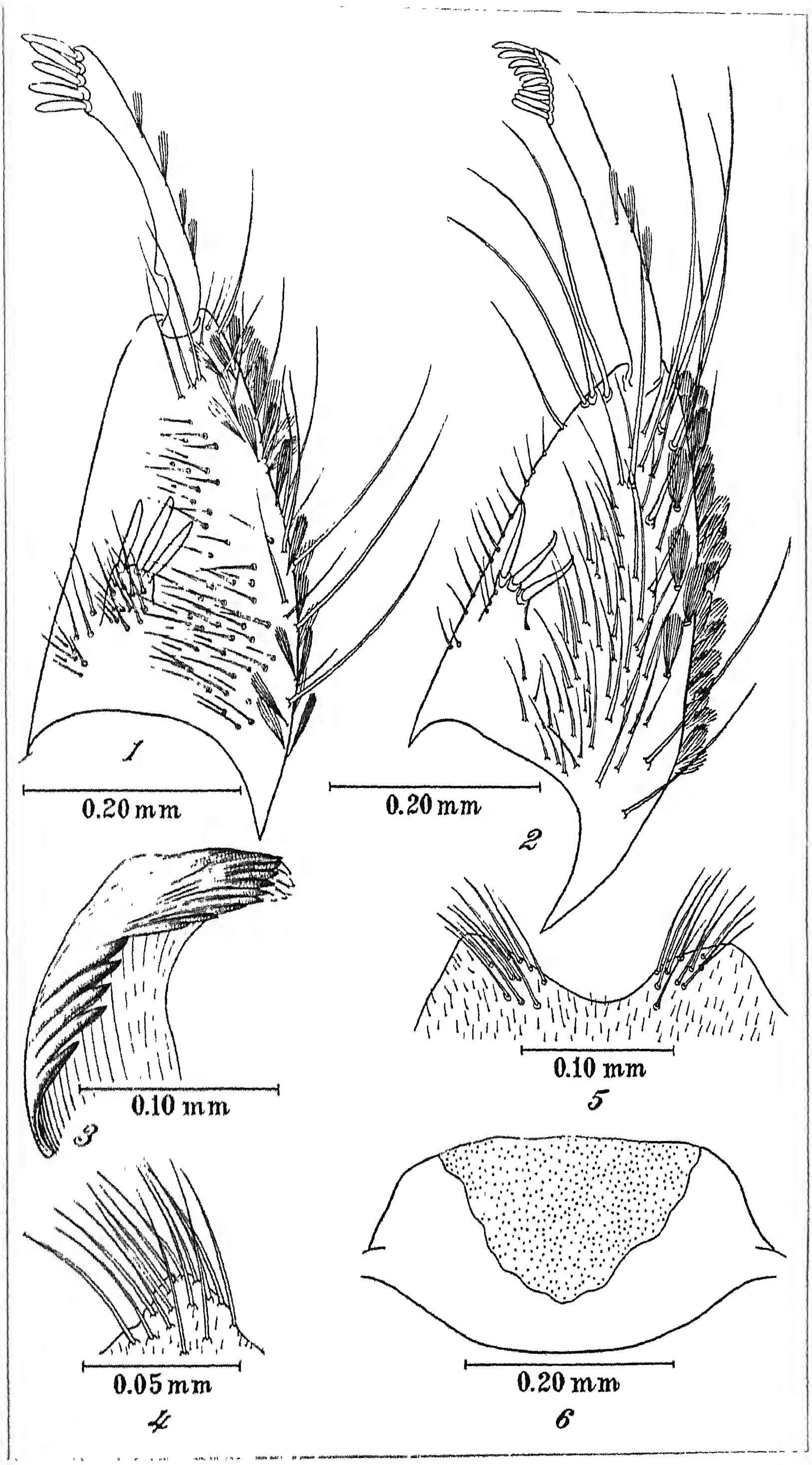


PLATE 4.

ADDITIONS TO THE APHID FAUNA OF FORMOSA (HEMIPTERA), III[1]

By Ryoichi Takahashi

Of the Department of Agriculture, Government Research Institute, Formosa

THREE TEXT FIGURES

EULACHNUS PINI sp. nov.

Wingless viviparous female.—Green, scarcely covered with secretions; body setæ dusky, each arising from a small dusky patch; cornicles, cauda, and anal plate dusky. In specimens treated with potash, antennæ pale brown; apex of fourth antennal joint, apical half of fifth, and sixth, except base, dusky; legs pale brown or brown, except tarsi and both ends of hind tibiæ, which are dusky. Body narrow, normal in shape, with many very long setæ, which are stout and tapering, but slightly capitate at the tip, and a little curved. Head divided by a median suture except on the posterior part, with some fourteen dorsal bristles including those on the front margin of dorsum, which are much longer than the first antennal joint. Eyes without distinct ocular tubercles. Antennæ slender, with long stiff or somewhat curved setæ, which are slightly capitate and shorter than those on the body; first joint as long as the longer setæ on the antennæ; second nearly as long as first, but much narrower, nearly twice as long as wide; third somewhat narrowed at the base, somewhat imbricated on distal half, lacking sensoria, with about seventeen setæ; fourth imbricated, with one or two small or rather large circular sensoria on distal half and about eight setæ; fifth with a very large oval or circular sensorium at tip; sixth with a similar sensorium at middle of distal part, which is somewhat smaller than that on fifth; relative lengths of joints about as follows: III—85 to 88, IV—42, V—45, VI—30 + 18. Rostrum reaching beyond middle coxæ. Cornicles small, not on cones. Cauda much wider than long, broadly rounded. Legs long, with many long slightly capitate setæ;

[1] Part II was published in the Philippine Journal of Science 52 (1933) 291–303.

setæ on tibiæ nearly as long as those on body; hind tibiæ very long, somewhat curved, much stouter than antennæ, slightly imbricated on distal part; tarsi long, imbricated, basal joint with a pair of long slightly capitate setæ on upper side, distal joint twice as long as basal; hind tarsi a little shorter than third antennal joint.

Length of body, about 3 millimeters; antenna, about 1.23; dorsal seta on head, about 0.138; hind tibia, about 1.57; hind tarsus, about 0.314; diameter of cornicle at apex, about 0.032.

Host.—*Pinus taiwanensis* Hayata, attacking the leaf.

Habitat.—Kyanrawa (altitude about 2,020 meters), Suo-gun.

Some specimens were collected by me August 15, 1934. The nymphs possess black legs. Closely allied to *Eulachnus piniformosanus* Takahashi, but differing in the following characters: (*a*) Body green, with scarce secretions; (*b*) body larger; (*c*) setæ darker, stouter, slightly capitate. Differs from the description of *Eulachnus tuberculostemmata* Theobald in the shorter rostrum, the cauda and anal plate black, the larger body, and the fourth antennal joint with one or two sensoria on the distal part.

AGRIOAPHIS ULMI-PARVIFOLIÆ Matsumura.

Tinocallis ulmi parvifoliæ MATSUMURA, Trans. Sapporo Nat. Hist. Soc. 7 2 (1919) 101.

Winged viviparous female.—Pale yellowish white; hind femora with a black part near distal end; wings slightly clouded at the end of each oblique and its branch and also at base of stigma. Head with three pairs of dorsal tubercles, of which the anterior two pairs are very short and conical, but the posterior pair is longer than wide. Antennæ slender, third joint with eleven to seventeen sensoria in most specimens, some with sixteen, in a row on the basal half, which are transversely narrowed. Pronotum with two pairs of stout dorsal tubercles that are longer than wide and larger than posterior ones on head; mesonotum with a pair of dorsal tubercles on hind part, which are nearly as long as those on pronotum. Abdomen with two pairs of dorsal tubercles on basal part, some with three lateral tubercles and some with very short indistinct dorsal ones; basal dorsal tubercles smaller than mesonotal ones. Cornicles wider than long, expanded basally, a little constricted about middle. Cauda knobbed, normal. Anal plate deeply bilobed, the lobes a little wider than long, as wide as cauda.

Host.—*Ulmus parvifolia* Jacquenot.

Habitats.—Habon (altitude, about 1,646 meters), near Musha; Kyanrawa (altitude, about 2,020 meters), Suo-gun.

Some specimens were taken by me August 10 and 15, 1934. Previously known from Honshu, Japan; new to Formosa. The Formosan specimens differ somewhat from the brief description by Matsumura, but no doubt belong to this species.

OREGMA ADERUENSIS sp. nov.

Wingless viviparous female.—Dark brown, with a purplish tinge, slightly covered with powder. Body oval, broadest on second abdominal segment, slightly convex dorsally. Dorsum slightly chitinized, with numerous rather small wax pores densely scattered over whole surface, except on eighth abdominal segment, and some long fine setæ somewhat curved; wax pores not well developed, indistinct, irregular in outline, but mostly nearly circular or oval, variable in size, separated from each other, semitransparent.

Head fused with prothorax, a little narrowed between antennæ, nearly straight on front between horns. Horns large, stout, as long as first antennal joint or slightly longer, somewhat diverging, narrowed on apical part, but rounded at tip, much longer than wide, sometimes slightly constricted basally and slightly curved, nearly as long as setæ on head, as long as distance between them or a little shorter, with a few short or long fine setæ. Eyes small, scarcely or not protruding laterally, with three facets. Antennæ short, curved, four-jointed, with a few rather long simple setæ, pale brown in specimens treated with potash; third joint somewhat narrowed on basal part, with a very small usual sensorium; relative lengths of joints about as follows: I—10, II—8, III—17, IV—11 + 4. Rostrum stout, not reaching middle coxæ. Cephalothorax, excluding horns, about one and one-half times as wide as long. Meso- and metathoracic and first and eighth abdominal segments defined, but second and following three abdominal segments fused, though sixth and seventh somewhat defined. Lateral setæ on abdomen a little longer. Cornicles short, not on hairy cones, much larger in

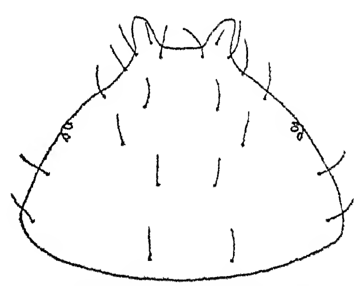


FIG. 1. *Oregma aderuensis* sp. nov.; cephalothorax of wingless viviparous female.

diameter at apex than dorsal pores. Cauda very short, but wide, somewhat constricted basally, broadly rounded on hind margin, with about six long setæ. Anal plate divided, each lobe slightly wider than cauda, with about six long setæ. Legs short, with some setæ; front tarsi with two very long setæ and two shorter ones on basal joint; hind tarsi a little longer than third antennal joint, with two very long setæ on basal joint; each distal tarsal joint with two very long fine setæ slightly capitate.

Length of body, about 1.65 millimeters; width of body, about 0.9; length of antenna, about 0.23; horn on front, about 0.051; hind tibia, about 0.37; diameter of apex of cornicle, about 0.032.

Host.—*Bambusa* sp., attacking the lower side of leaf.

Habitats.—Aderu (altitude about 1,170 meters), Heito-gun; Suisha.

Many specimens were taken by me November 23, 1929, and January 26, 1930, at Suisha, and a few specimens March 24, 1934, at Aderu. Described from specimens collected at Aderu. Closely allied to *Oregma tattakana* Takahashi, but differing in that the head is narrowed between the antennæ and the horns are narrowed on the apical part, as well as in the stouter tibiæ. Easily distinguished from *Oregma tattakana* Takahashi var. *suishana* Takahashi by the color.

MACROSIPHUM MONTICOLUM sp. nov.

Wingless viviparous female.—Green, slightly dusky near bases of cornicles; antennæ black, paler on basal part of third joint, not black on basal two joints, which are pale brown in specimens treated with potash; cornicles entirely black; cauda yellowish green; legs black on tarsi, distal parts of tibiæ, and distal halves of femora; body setæ pale. Body normal in shape, not imbricated, without granules and spinules on dorsum, but with many long stout setæ, which are somewhat curved, slightly or scarcely capitate, and each arising from a small tubercle. No thickened parts discernible on dorsum in specimens treated with potash. Head with four or five setæ in a transverse row between eyes, and two pairs of similar setæ in front of row. Frontal tubercles well developed, slightly convex, and with two setæ on mesal side, diverging, nearly as long as second antennal joint; setæ slightly or scarcely capitate. Antennæ very long and slender, with some rather long setæ, which are slightly capitate or simple and shorter than those on head; first joint slightly convex on mesal side, about twice as long as second; third somewhat striate on

basal part, with eighteen to twenty-two small, circular, slightly protruding sensoria, scattered except on basal and distal parts, and about twenty-two setæ; fourth slightly imbricated, wanting sensoria, with about eleven to thirteen setæ; relative length of joints about as follows: III—50, IV—33, V—32, VI—10 + 60. Eyes normal. Rostrum reaching hind coxæ, with some eight pairs of rather long lateral setæ, and many transverse rows of minute granules on basal joint. Prothorax with a very small, rounded, lateral tubercle. Setæ on thorax and abdomen nearly as long as those on head. Cornicles long, cylindrical, slightly curved, a little dilated towards base, not dilated at base, not swollen, imbricated, distinctly reticulated on distal one-fifth, about twice as long as cauda, a little longer than third antennal

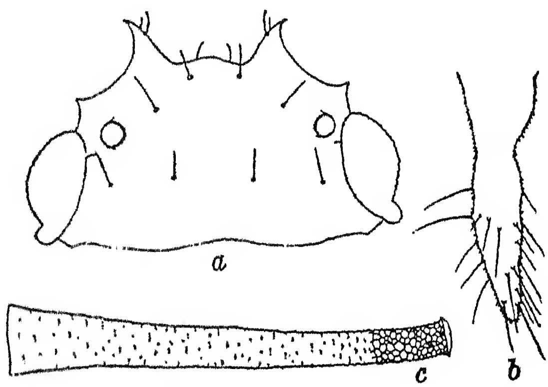


FIG. 2. *Macrosiphum monticolum* sp. nov.; winged viviparous female; *a*, head; *b*, cauda; *c*, cornicle of wingless female.

joint. Cauda long, constricted, rounded apically, with many setæ. Legs long and slender, with many rather long stiff setæ; hind tarsi nearly as long as basal part of last antennal joint, with five setæ on basal joint.

Length of body, about 2.6 millimeters; antenna, about 3; cornicle, about 0.9; cauda, about 0.47; hind tibia, about 2; seta on head, about 0.09; width of cornicle about middle, about 0.073.

Winged viviparous female.—Green, slightly dusky near bases of cornicles; head dusky; antennæ black, paler at base of third joint; cornicles black; cauda yellowish green; mesothorax pale brownish in specimens treated with potash, wings hyaline, stigma black, veins dusky; legs nearly as in wingless form. Third

antennal joint with about thirty-eight sensoria scattered except on the basal small part; fourth lacking sensoria; relative length of joints about as follows: III—54, IV—38, V—37, VI—10 + 75. Cornicles somewhat shorter than third antennal joint, expanded basally, slightly more than twice as long as cauda. Wing veins normal. Hind tarsi with five setæ on basal joint.

Length of body, about 2.6 millimeters; cornicle, about 0.78; cauda, about 0.32; hind tibia, about 1.9; forewing, about 3.5; seta on head, about 0.046; width of cornicle about middle, about 0.06.

In a winged form, hind tibiæ with numerous small circular or oval sensoria on basal half and cauda wider. This specimen is a viviparous female and is no doubt an abnormal form.

Host.—A plant of the Compositæ.

Habitats.—Miharashi (altitude about 883 meters), Taito; Riyohen (altitude about 1,121 meters), Rato-gun.

Some specimens were taken by me September 6, 1929, at Riyohen, and March 22, 1934, at Miharashi. This species seems to be closely related to *Macrosiphum parvum* Shinji, briefly described from *Aster* in Japan,[2] but differs from Shinji's description in possessing more sensoria on the third antennal joint, which is longer than the fourth, the fourth antennal joint as long as the fifth, and the femora paler on the basal part. Easily distinguished from *Uroleucon sonchi* Linnæus by the color. In the system of classification by Boerner this species must be included in *Dactynotus* Raf. (synonym, *Uroleucon* Mordwilko).

MACROSIPHUM TAIHEISANUM sp. nov.

Wingless viviparous female.—Entirely blackish brown. In specimens treated with potash, slightly pale brown, with many small dusky patches on sides and on posterior half of abdomen; abdomen likewise dusky on lateral part behind the cornicle; anal plate dusky; cornicles pale brownish, dusky on distal one-third; caudal pale brown; coxæ, femora, and tarsi black; tibiæ pale yellowish brown, black on basal and distal parts. Head somewhat chitinized, slightly corrugated on posterior part of dorsum, not imbricated, wanting granules, with a faint suture on anterior part of dorsum, a rounded frontal protuberance not visible from above, a pair of moderate, scarcely capitate, setæ on front, and also between antennæ, and two pairs of similar setæ between eyes. Frontal tubercles distinct, but short, not imbricated,

[2] Dubutsugaku Zasahi 34 (1922) 788.

slightly convex on mesal side. Eyes rather small. Antennæ long, slender, with some very small setæ; first joint as long as wide, somewhat angulated on mesal side, somewhat imbricated; third wanting sensoria; fourth somewhat imbricated; relative lengths of joints about as follows: III—37, IV—17, V—16, VI—10 + 20. Rostrum stout, reaching middle coxæ, with a pair of very long setæ near apex, which are directed laterally. Thorax and abdomen densely corrugated over dorsum and seeming to possess many, short, rounded papillæ, with a few short dorsal setæ, which are somewhat lanceolate. Cornicles long, rather stout, curved, directed posteriorly, nearly reaching middle or apex of cauda, not reticulated, distinctly imbricated on distal part and on mesal side, but not on basal part, gradually narrowed towards apex, a little longer than third antennal joint,

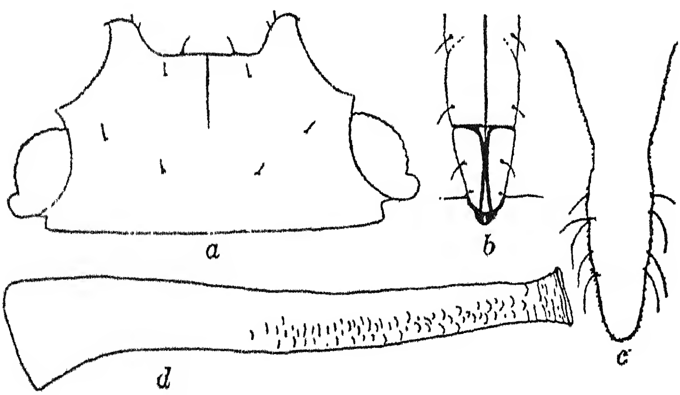


FIG. 8. *Macrosiphum taiheisanum* sp. nov.; wingless viviparous female; *a*, head; *b*, distal part of rostrum; *c*, cauda; *d*, cornicle.

twice as long as cauda. Cauda long, rounded apically, with a distinct constriction and about four or five long lateral setæ. Legs long, with many rather short setæ; tarsi imbricated, middle tarsi with three setæ on the basal joint. Anal plate rounded, with many long fine setæ.

Length of body, about 2.5 millimeters; antenna, about 2; cornicle, about 0.7; cauda, about 0.36; middle tibia, about 1; hind tibia, about 1.5; width of head at hind margin, about 0.44.

Host.—*Rhododendron formosanum* Hemsley, attacking the upper side of leaf on the midrib.

Habitat.—Taiheisan (altitude about 1,400 meters).

Four adult females were taken by me May 21, 1931. This species is peculiar in the corrugated dorsum and the curved

cornicles imbricated on the mesal side, and is not a typical form of the genus. Publication of the description of this species has been delayed in the hope that more specimens, including the winged forms, might be collected, but this hope has not materialized.

The type specimens are in the collection of the Department of Agriculture, Government Research Institute, Formosa.

ILLUSTRATIONS

TEXT FIGURES

EINIGE UNBESCHRIEBENE CURCULIONIDEN AUS DEM INDOMALAYISCHEN ARCHIPEL

58. BEITRAG ZUR KENNTNIS DER CURCULIONIDEN

Von EDUARD VOSS

Berlin-Charlottenburg, Deutschland

EINE TEXTFIGUR

Genus AULETORHINUS novum

Kopf quer, hinter den Augen undeutlich eingezogen. Augen stark halbrund vorgewölbt; die Stirn etwas breiter als die Augen lang. Rüssel schlank, fast gerade. Labrum vorhanden. Palpen starr. Fühler in der Nähe der Rüsselbasis eingelenkt. Keule lose gegliedert. Halsschild im basalen Drittel seitlich stark gerundet, konisch. Schildchen dreieckig. Flügeldecken länger als breit, unregelmässig punktiert; Schulterbeule schwach entwickelt. Pygidium gross, von den Flügeldecken unbedeckt. Tibien schlank, gerade. Klauen gespalten.

LARAT-INSELN.

Genotypus, *A. hirtellus* sp. nov.

Eine Art von ausgesprochener *Auletobius*-Gestalt, doch mit anscheinend noch flexiblem Labrum und vollständig unbedecktem Pygidium: so lässt sich diese eigenartige Rhynchitine am besten charakterisieren. Es bestände die Möglichkeit, diese Gattung unter den Tribus Rhinocartini zu stellen, abgesehen jedoch davon, dass bei den Arten der beiden hierhergehörenden Gattungen das Labrum mehr oder weniger verschmolzen und das Pygidium nur teilweise von den Flügeldecken bedeckt ist, ist auch die Rüssel- und Fühlerbildung eine andere, und in die unregelmässige Punktierung der Flügeldecken mischen sich gereihte Punkte. Es erscheint daher zweckmässig, diese Gattung einem besonderen Tribus Auletorhinini zuzuweisen, die zwischen die Auletini und Rhinocartini einzufügen wäre.

AULETORHINUS HIRTELLUS sp. nov.

Kopf fein und sehr dicht punktiert. Rüssel so lang wie Kopf and Halsschild zusammen, glänzend, gerade, zur Spitze hin leicht geradlinig verbreitert. Labrum dreieckig, an der Spitze leicht

abgerundet. Rüsselbasis mit kurzer Mittelfurche. Fühler um reichlich Schaftgliedlänge von den Augen entfernt eingelenkt. Schaft- und erstes Geisselglied gleichlang, jedes länger als breit; zweites Glied fast so lang wie Schaft- und erstes Geisselglied zusammen; drittes und viertes Glied so lang wie das erste Glied; fünftes bis siebentes Glied wenig kürzer, von annähernd gleicher Länge. Erstes und zweites Glied der Keule breiter als lang; drittes Glied mit dem Endglied so lang wie das erste und zweite Glied zusammen. Halsschild fast so lang wie breit, im basalen Drittel seitlich kräftig gerundet, nach vorn stark konisch verschmälert, vor dem Vorderrand leicht eingeschnürt. Punktierung kräftig und sehr dicht. Flügeldecken etwas weniger kräftig punktiert, mit leichter Neigung zu gereihter Anordnung. Der Nahtstreif ist bis kurz vor dem Schildchen herangeführt. Pygidium gross, dreieckig, kaum erkennbar punktiert. Hinterbrust mit Seitenteilen hochglänzend, sehr fein zerstreut punktiert, Abdomen mässig stark runzlig skulptiert.

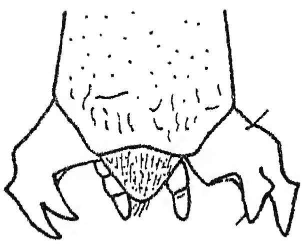


FIG. 1. *Auletorhinus hirtellus* gen. et sp. nov., Rüsselspitze.

Färbung schwarz, oben mit Bleiglanz; die Wurzel der Geisselglieder rötlich aufgehellt; Mandibeln und Labrum rot. Behaarung greis, mässig lang niederliegend, teilweise untermischt mit längeren abstehenden Haaren. Länge, 2 millimeter.

LARAT-INSELN (*F. Muir*). British Museum of Natural History.

LASIORRHYNCHITES (PSEUDOCOENORRHINUS) CARINICOLLIS sp. nov.

Männchen.—Kopf etwas länger als breit, zylindrisch, vor der Basis ringsum schwach abgeschnürt, kräftig und sehr dicht, zum Teil runzlig punktiert. Augen mässig stark vorgewölbt, die Stirn so breit wie der Rüssel an der Basis. Rüssel so lang wie der Halsschild, schwach gebogen, bis kurz vor die Spitze oben parallelseitig, dann schwach verbreitert; die Basalhälfte mit stumpfem Mittelkiel, der seitlich von einer kräftigen Punktfurche begleitet wird; zwischen der Fühlerbasis mit breiterem Eindruck; vorn, oben, glänzend, seitlich fein gereiht punktiert. Fühler wenig vor der Rüsselmitte eingelenkt. Schaft- und erstes Geisselglied gleichlang, etwa anderthalb mal so lang wie breit, oval; zweites Geisselglied fast so lang wie Schaft- und erstes Geisselglied zusammen; drittes Glied etwas länger als

das Schaftglied; viertes und fünftes Glied so lang wie letzteres; sechstes und siebentes Glied so lang wie breit. Keule kräftig, lose gegliedert, das erste und zweite Glied breiter als lang, gleichlang; das dritte Glied mit dem kegelförmigen Endglied anderthalb mal so lang wie das erste Glied. Halsschild fast etwas länger als breit, seitlich schwach und gleichmassig gerundet, Vorderrand und Basis leicht abgeschnürt, ersterer etwas weniger breit als letztere. Punktierung kräftig und sehr dicht. Mittelkiel in der Mitte linienförmig gefurcht, die Basis und den Vorderrand nicht ganz erreichend. Schildchen dreieckig mit leicht abgestutzter Spitze. Flügeldecken reichlich anderthalb mal so lang wie breit, hinten wenig gerundet verbreitert. Skutellarstreif nur beim Weibchen deutlich, der verkürzte Randstreif kurz, weit vor den Hinterhüften mit dem vorletzten Streif vereinigt. Punktstreifen mässig stark, schwach gefurcht; Zwischenräume schmal, leicht gewölbt, nicht ausgesprochen einreihig punktiert, da verschiedene Punkte ausser der Reihe angeordnet sind, die Punkte fein, dicht stehend. Punktierung der Hinterbrust fein und verschwommen, der Seitenteile kräftiger und sehr dicht. Tibien schlank und gerade.

Weibchen.—Rüssel etwas länger als das Halsschild.

Färbung rot. Behaarung der Flügeldecken fein, anliegend, greis; des Abdomens abstehend. Länge 3.7 bis 4.8 millimeter.

NORD-BURMA, Adung Valley in 6,000 bis 12,000 Fuss Höhe (August, 1931, *Lord Cranbrook;* März, 1931, *Kingdon Ward*). British Museum of Natural History; in meiner Sammlung.

Wenn diese Art unter die Gattung *Lasiorrhynchites* gestellt würde, so dies auf Grund des beim Weibchen deutlich erkennbaren, beim Männchen angedeuteten verkürzten Skutellarstreifs, des ringsum schwach abgeschnürten Kopfes und der das Pygidium zum Teil verdeckenden Flügeldecken. Die kurze anliegende Behaarung bringt diese Art in nächste Nähe der Untergattung *Pselaphorrhynchites* unter *Coenorrhinus.* Sie ist hinter die Untergattung *Stenorhynchites* einzustellen, der sie im übrigen sehr nahe steht, macht aber auf Grund der anders gearteten Behaarung und des gebogenen Rüssels die Aufstellung einer besonderen Untergattung erforderlich, für welche der Name *Pseudocoenorrhunis* vorgesehen wurde.

TRACHELOLABUS BURMAENSIS sp. nov.

Kopf etwa doppelt so lang wie breit, von der Basis zu den Augen schwach geradlinig verbreitert. Augen verhältnismässig

klein, wenig vorgewölbt. Stirn etwa anderthalb mal so breit wie die Augen lang. Kopf der ganzen Länge nach fein gefurcht. Rüssel etwa ein und ein Viertel mal so lang wie breit, von der Basis nach vorn schwach geradlinig verbreitert. In der Mitte kräftig aufgewölbt, die Aufwölbung vorn zahnartig unterschnitten; seitlich derselben die Fühler eingelenkt. Schaftglied nicht ganz doppelt so lang wie breit; erstes Geisselglied etwas kürzer als das Schaftglied; zweites bis viertes Glied etwas länger als das Schaftglied; fünftes und sechstes Glied wenig länger als das erste Glied; siebentes Glied scheinbar zur Keule gehörig, länger als breit. Glieder der Keule kurz, quer. Halsschild etwa so lang wie breit, konisch, im basalen Teil schwach gerundet, vorn etwa halb so breit wie an der Basis. Mit feiner Mittelfurche, die zur Basis hin tiefer eingedrückt ist; beiderseits der Mitte mit je einer runden Grube. Im ganzen fein querriefelig. Schildchen quer, trapezförmig. Flügeldecken etwa ein und drei Viertel mal so lang wie breit, parallelseitig. Punktstreifen kräftig, grubenförmig, die Punkte einzeln stehend; nur der Skutellarstreif feiner punktiert. Hinten in gleicher Stärke wie vorn punktiert. Zwischenräume kaum gewölbt, schmaler als die Streifen. Unterseite fein und dicht punktiert. Alle Tibien dünn, gerade, die vorderen etwas weitläufig gezähnt. Schenkel fein gezähnt, die vorderen mit kurzem, dornförmigem Zahn.

Färbung metallischgrün, das siebente Geisselglied stahlblau, Keule schwarz. Unterseite und Flügeldecken mit kurzen anliegenden Härchen von ebenfalls glänzender olivgrüner Farbe, die sich vor und hinter der Mitte der Decken undeutlich querbindenartig gruppieren. Länge, 5 bis 6 millimeter.

NORD-BURMA, Adung Valley in 8,000 Fuss Höhe (Mai, 1931, *Kingdon Ward;* Juni, 1931, *Lord Cranbrook*). British Museum of Natural History; in meiner Sammlung.

Eine Art, die dem mir unbekannten *Trachelolabus whitei* Jekel nahe steht, sich aber der Beschreibung nach in mehrfacher Hinsicht unterscheidet. So ist der Halsschild nicht länger als breit, ohne zwei hintereinander angeordnete Quereindrücke, die Punkte der Streifen werden hinten nicht feiner und die Anordnung und Art der Behaarung scheint ebenfalls abzuweichen.

HENICOLABUS INTERMEDIUS sp. nov.

Männchen.—Kopf ohne Augen etwa anderthalb mal so lang wie breit, schwach konisch nach vorn verschmälert, hinter den

Augen mit sichtem Quereindruck, vor diesem mässig stark und dicht punktiert, die Stirn mit Mittelkiel. Augen stark halbkugelig vorgewölbt. Rüssel anderthalb mal so lang wie breit, im basalen Teil parallelseitig, von der Mitte ab nach vorn verbreitert, an der Basis stumpfwinklig abwärts gebogen, vorn fein und weitläufig, seitlich dichter und kräftiger punktiert; Fühlereinlenkungsstelle mässig aufgewölbt und schwach längsgefurcht. Fühler fast im basalen Drittel des Rüssels eingelenkt. Schaft- und erstes Geisselglied gleichlang, länger als breit; zweites und drittes Glied wenig länger; viertes bis sechstes Glied etwas länger als breit; siebentes Glied etwas breiter als lang. Erstes Glied der Fühlerkeule etwas länger als breit; zweites Glied viel breiter als lang; drittes Glied mit dem Endglied zugespitzt und fast so lang wie das erste und zweite Glied zusammen. Halsschild etwas breiter als lang, seitlich nahezu parallelseitig, von der Mitte nach vorn kräftig gerundet verschmälert; hinter dem Vorderrand mit kräftigerem, dichter punktiertem Eindruck, im übrigen feiner und weniger dicht punktiert, die Mitte mit fast unpunktiertem, breiterem Band; seitlich der Mitte beiderseits mit undeutlichem Grübchen. Schildchen etwa so lang wie breit, trapezförmig. Flügeldecken etwa ein und drei Viertel mal so lang wie breit, parallelseitig; Schultern zahnförmig erhaben, der Zahn jedoch von oben undeutlich zu sehen. Punktstreifen mässig kräftig, nach hinten zu allmählich feiner werdend, die Punkte hier um etwa ihren doppelten Durchmesser von einander entfernt stehend; Zwischenräume flach, so breit oder breiter als die Streifen, fein einreihig punktiert. Pygidium fein und nicht dicht punktiert. Abdomen fein und dicht, schwach runzlig verlaufen punktiert; Mittel- und Hinterbrust mit Seitenteilen kräftiger runzlig punktiert. Vorderschenkel sehr kräftig keulenförmig mit starkem Schenkelzahn, Vordertibien kräftig, gerade, innen leicht geschweift, kräftig und ziemlich dicht mit Höckerchen besetzt; Mittel- und Hinterbeine kürzer und schwächer, die Hintertibien in der basalen Hälfte nach innen schwach durchgebogen.

Weibchen.—Der Zahn der Vorderschenkel ist viel schwächer als beim Männchen. Färbung rot bis rotbraun, in letzterem Falle sind die Fühler und die Flügeldecken mit Ausnahme der Seiten und der Naht aufgehellt. Die Unterseite mit metallischglanzenden, anliegenden Härchen ziemlich dicht besetzt. Länge, 8 millimeter.

BORNEO: Sarawak, Mount Merinjak in 2,200 Fuss Höhe (*Bryant*, Mai, 1914). British Museum of Natural History; in meiner Sammlung.

Diese Art ist ein nächster Verwandter des *H. fausti* m. Von letzterer Art unterscheidet sie sich durch die mehr oberständige zahnartige Aufwölbung der Schultern, sodass der Zahn in der Aufsicht wenig deutlich ist. Das zweite Glied der Fühlerkeule ist quer und der Halsschild sparsamer und weniger dicht punktiert.

PARAPLAPODERUS PERAKENSIS sp. nov.

Weibchen.—Kopf mit Augen breiter als lang, die Schläfen von den Augen ab kurz parallelseitig, dann in gemeinsamem Bogen zugerundet; Augen kräftig vorgewölbt, die Stirn gut anderthalb mal so lang wie breit. Rüssel etwa so lang wie breit, seitlich kräftig eingezogen, die schmälste Stelle liegt kurz hinter der Mitte. Punktierung undeutlich. Fühler kurz vor der Basis eingelenkt. Schaftglied gut doppelt so lang wie breit; erstes Glied oval, etwas länger als breit; zweites bis viertes Glied so lang wie das erste Glied; die restlichen Glieder quer. Erstes Glied der Fühlerkeule länger als breit; zweites Glied so lang wie breit; drittes Glied breiter als lang; Endglied kurz und spitz. Halsschild fast doppelt so breit wie lang, von der kräftigen subbasalen Einschnürung ist das Scutum in starkem Bogen nach vorn verschmälert; Praesegmentalring kurz kragenförmig und nur etwa ein Fünftel so breit wie der Postsegmentalring. Oberseits ist das Scutum beiderseits der schwachen Mittelfurche abgeflächt, an der Basis seitlich schwach aufgewölbt, im ganzen kräftig und sehr dicht runzlig punktiert. Schildchen dreieckig, mit abgestutzter Spitze, hinten schwach aufgewölbt. Flügeldecken etwas länger als breit, von den Schultern ab kurz parallelseitig, dann im massiger Rundung verbreitert. Schultern aussen mit kleinem Kegelhöcker, innen und aussen gekerbt und innen ohne Höcker. Discoidalhöcker stark kegelförmig als Stachel ausgebildet; Subsuturalnerv kurz hinter der Mitte der Flügeldecken rechtwinklig nach aussen abgebogen und dann spitzwinklig wieder zur Naht verlaufend, an der Knichkstelle etwas aufgewölbt. Pygidium kräftig und sehr dicht punktiert, Abdomen feiner und dicht, Hinterbrust mit Seitenteilen kräftig runzlig. Das letzte Abdominalsegment ist seitlich schwach lappenförmig vorgezogen; Mittelbrust vor den Mittelhüften mit kräftigem, spitzem Höcker; Vorderhüften vor der Spitze vorn mit schwachem Höckerchen. Tibien gerade.

Färbung zinnoberrot; schwarz gefärbt sind: eine kleine Makel beiderseits auf dem Halsschild, der Discoidalhöcker, beziehungsweise -Stachel, die kleine subapikale Subsuturalmakel, und eine Makel auf den Hinterbrustepimeren; das grössere apikale Drittel der Hinterschenkel ist ebenfalls schwarz gefärbt. Länge, 8 millimeter.

PERAK (*Doherty*). British Museum of Natural History; in meiner Sammlung.

Leider liegt das Männchen dieser Art nicht vor, sodass nur vermutet werden kann, dass sie zur zweiten Gruppe[1] gehört und hier hinter *P. breviceps* m. einzuordnen ist. Die sparsame Fleckenzeichnung, der scharf stachelförmig ausgebildete Discoidaldorn bei nur schwacher Schulterbewehrung machen die Art unter den Verwandten leicht kenntlich.

TOMAPODERUS DOHERTYI sp. nov.

Männchen.—Kopf mit Augen etwa ein und ein Viertel mal so lang wie breit, von den Augen in leichtem Bogen nach hinten zu konisch verschmälert. Stirn durch eine Querfurche vom Rüssel abgesetzt, von der zwei kleine flatenartige Furchen zur Stirn ausstrahlen, die Stirn doppelt so breit wie die Augen lang. Augen mässig stark vorgewölbt. Rüssel breiter als lang, von der Basis nach vorn verbreitert, seitlich vereinzelt punktiert. Fühler im basalen Drittel eingelenkt. Schaftglied keulenförmig, gut doppelt so lang wie breit; erstes Geisselglied oval, länger als breit; zweites bis viertes gleichlang, verkehrt kegelförmig, so lang wie das erste Glied; die restlichen Glieder breiter als lang. Erstes Glied der Fühlerkeule so lang wie breit; zweites Glied breiter als lang; drittes Glied mit dem Endglied so lang wie das erste Glied. Halsschild breiter als lang, leicht gerundet und stark konisch von der subbasalen Querfurche nach vorn verjüngt. Praesegmentalring kragenförmig abgesetzt; Scutum mit mässig starker Mittelfurche und seitlich derselben mit mehr oder weniger kräftigem Eindruck, unpunktiert und nur stellenweise mit leicht gekräuselter Sculptur. Schildchen dreieckig mit breit abgerundeter Spitze. Flügeldecken kaum ein und ein Viertel mal so lang wie breit, im basalen Teil nahezu parallelseitig, nach hinten zu schwach gerundet verbreitert; Punktstreifen mässig stark, die Punkte um etwa ihren Durchmesser oder etwas weniger von einander entfernt stehend, nicht furchig vertieft; Zwischenräume breit, flach, gleichmässig dicht unre-

[1] Stett. Ent. Ztg. 87 (1926) 43.

gelmässig punktiert. Pygidium kräftig und ziemlich dicht punktiert. Punktierung der Unterseite sparsam. Schultern mit seitlich vorstehendem Tuberkel. Tibien gerade.

Weibchen.—Der Halsschild ist weniger konisch und seitlich mehr ausladend gerundet geformt, der seitlich der Mittelfurche des Scutums gelegene Eindruck gestaltet sich mehr ringförmig und schliesst eine schwach aufgewölbte Partie ein.

Färbung gelbrot; schwarz mit blauem Schein ist der Kopf unterseits, eine runde Makel auf der Stirn (bisweilen fehlend oder undeutlich), Halsschild-Unterseite, mit Ausnahme der Hüften, oberseits eine längliche Mittelmakel im apikalen Teil gelegen und kurz vor der subbasalen Querfurche aufhörend; das Schildchen, ein breites basales Querband, hinter dem Schildchen weiter ausgedehnt, ein breites an der Naht unterbrochenes Querband auf der Mitte der Flügeldecken und schliesslich die Spitze der Flügeldecken in weiterem Umfang. Der schmale Rand der Flügeldecken, die Mittel- und Hinterbrust mit Seitenteilen und das Abdomen mit Ausnahme des Randes ebenfalls von schwarzer Färbung. Pygidium mit zwei schwarzen Flecken. Länge, 6.5 bis 7 millimeter.

OST-INDIEN, Manipur (*Doherty*). British Museum of Natural History; in meiner Sammlung.

Die erste bekannt gewordene *Tomapoderus*-Art mit Fleckenzeichnung und damit ausser durch den breiten, beim Männchen kräftig konisch verjüngten Halsschild hierdurch leicht zu erkennen. Die schöne Art möge ihrem Entdecker zu Ehren benannt sein.

CYCNOTRACHELUS FLAVONOTATUS sp. nov.

Männchen.—Kopf etwa doppelt so lang wie breit, leicht gerundet konisch, die Stirn reichlich anderthalb mal so breit wie die mässig stark vorgewölbten Augen lang. Hals erheblich länger als der Kopf, dicht ringförmig geriefelt. Rüssel gut doppelt so lang wie an der Spitze breit und hier viel breiter wie im basalen Teil, vor der Mitte an der Fühlereinlenkung kräftig aufgewölbt, im basalen Teil mit scharfen Randfurchen, die divergierend zur Stirn auflaufen. Schaftglied stark, anderthalb mal so lang wie breit; erstes Geisselglied wenig länger als breit; zweites Glied etwas länger als das erste; drittes bis fünftes Glied fast doppelt so lang wie das erste Glied; sechstes und siebentes Glied quer. Erstes und zweites Glied der Fühlerkeule gleichlang, jedes anderthalb mal so lang wie breit; drittes Glied

quer; Endglied spitz ausgezogen, gebogen. Halsschild viel länger als breit, seitlich stark konkav gerundet, kräftig querriefelig, hinter dem Praesegmentalring mit halbkugelförmiger Aufwölbung. Flügeldecken etwas länger als breit, fast parallelseitig. Punktstreifen ziemlich kräftig; Zwischenräume breiter als die Streifen, leicht gewölbt, glänzend, unpunktiert. Die Flügeldecken tragen folgende Tropfenflecke: Auf dem zweiten Zwischenraum befindet sich im basalen Viertel eine Makel, die auf der rechten Flügeldecke einer L und auf der linken dem Spiegelbild einer solchen entspricht; auf dem gleichen Zwischenraum auf der Mitte eine länglich ovale Makel, auf dem dritten und vierten Zwischenraum in der Länge des basalen Viertels je eine sich nach hinten keilförmig verbreiternde Makel; auf der Mitte der Flügeldecken ausser der bereits erwähnten auf dem zweiten Zwischenraum je eine weitere auf dem vierten, sechsten und achten Zwischenraum, von denen diejenige auf dem vierten Zwischenraum etwas schmaler und mehr nach hinten, die anderen wieder in etwa gleicher Höhe mit der inneren Tropfenmakel angeordnet sind, und diejenige auf dem achten Zwischenraum mehr strichförmig ausgebildet ist. Vor der Spitze der Flügeldecken hat dann der zweite und vierte Zwischenraum eine grosse gemeinsame Makel und schliesslich sind die Schultern gelb gefärbt.

Weibchen.—Halsschild breiter als lang, mit tief abgeschnürtem Praesegmentalring; die Mitte der Länge nach gefurcht und die etwas schwächere Aufwölbung hinter dem Praesegmentalring ringsum von einer Furche begrenzt.

Färbung bräunlichrot mit den vorstehend näher beschriebenen dottergelben Tropfenzeichnungen auf den Flügeldecken. Länge, 6.8 bis 13 millimeter.

BURMA, Ruby Mines; Momeit. British Museum of Natural History; in meiner Sammlung.

Dadurch, dass beim Weibchen der Praesegmentalring des Halsschilds kräftig abgeschnürt ist, trennt sich die Art von *flavotuberosus* Jekel and müsste auf Grund dieses Merkmals zum Formenkreis *satelles* Pascoe und *flavoguttatus* m. gezogen werden, die jedoch auf dem achten Zwischenraum der Decken ungemakelt sind. Die Art steht also zwischen *flavotuberosus* und *satelles;* und auch recht glücklich, weil beide Arten glänzende, unpunktiert Zwischenräume besitzen, im Gegensatz zu *flavoguttatus* m. aus Indien and China.

EUOPS IGNITA sp. nov.

Weibchen.—Kopf kurz, hinter den Augen mit feiner, punktierter Einschnürungsfurche, sonst unpunktiert. Augen wenig vorgewölbt. Rüssel etwa anderthalb mal so lang wie breit, von der Basis geradlinig nach vorn verbreitert, sehr fein und weitläufig punktiert. Fühler basal eingelenkt. Schaftglied nicht ganz doppelt so lang wie breit; erstes Geisselglied noch etwas kräftiger als das Schaftglied, oval; die nächsten Glieder schwächer; Zweites Glied so lang wie das erste Glied; drittes Glied kürzer; viertes Glied fast so lang wie das zweite Glied; die restlichen Glieder quer. Fühlerkeule fast so lang wie die Geissel; erstes Glied so lang wie breit; zweites Glied etwas kürzer; drittes Glied mit dem Endglied etwas länger als das erste Glied. Halsschild breiter als lang, fast gerandlinig kônisch, stark nach vorn verschmälert, fein und mässig dicht punktiert. Schildchen viereckig, etwa so lang wie breit. Flügeldecken etwa ein und ein Viertel mal so lang wie breit, von den Schultern ab fast geradlinig und nur schwach zur Mitte hin verschmälert, dann in gleichmässigem Bogen zur Spitze verrundet. Punktstreifen mässig stark, die Punkte schmal getrennt; Zwischenräume kaum gewölbt, sehr fein einreihig punktiert. Pygidium fein und sehr dicht punktiert, Abdomen weniger dicht, Hinterbrust mit Seitenteilen ziemlich dicht punktiert. Hintertibien im apikalen Drittel ziemlich kräftig einwärts gebogen.

Färbung stahlblau, Abdomen und Pygidium mit leichtem Bronzeschein; Flügeldecken tief metallisch rot gefärbt; Fühler pechbraun. Länge, 2 bis 2.5 millimeter.

BURMA, Ruby Mines (*Doherty*). British Museum of Natural History; in meiner Sammlung.

Die Art ist nahe verwandt mit *Euops tonkinensis* m. und mit *gardneri* Marshall.[2]

EUOPS (SUNIOPS) SUBDENTATA sp. nov.

Männchen.—Kopf kurz, hinter den Augen nur mit vereinzelten feinen Punkten besetzt. Rüssel anderthalb mal so lang wie breit, von der Seite gesehen, zur Spitze verjüngt. Fühler in der Nähe der Rüsselbasis eingelenkt. Schaft- und erstes Geisselglied gleichlang, etwa anderthalb mal so lang wie breit, das Schaftglied etwas keulenförmig, das erste Geisselglied oval; zweites und viertes Glied wenig kürzer als das erste Glied, verkehrt

[2] Philip. Journ. Sci. 50 (1933) 114.

kegelförmig, viel schwächer; fünftes und sechstes Glied noch länger als breit; siebentes Glied so lang wie breit. Erstes Glied der Keule etwas länger als breit; zweites Glied so lang wie breit; drittes Glied mit dem Endglied so lang wie das erste Glied. Halsschild etwas breiter als lang, seitlich kräftiger gerundet, die grösste Breite im basalen Drittel. Punktierung fein, weitläufig, seitlich etwas kräftiger, die Zwischenstege oberseits leicht querriefig verlaufend. Schildchen quer, hinten leicht gerundet. Flügeldecken so lang wie breit, von den Schultern geradlinig nach hinten verschmälert, an der Spitze einzeln gerundet. Punktstreifen mässig kräftig, hinten kaum feiner werdend; Zwischenräume breiter als die Streifen, nach innen zu etwas abfallend, fein weitläufig, einreihig punktiert. Vordertibien wenig schlank, nur im apikalen Drittel leicht gebogen, im übrigen Teil fast gerade, innen fein gezähnt. Die äussere Leiste gezähnt: Ein Endzahn kräftiger; vier weitere feiner, doch etwas kräftiger als die Innenzähnelung, der zweite und dritte Zahn um etwa Zahnhöhe, die übrigen um etwa anderthalb Zahnhöhe von einander entfernt stehend; in etwas weiterem Abstand folgt ein kleines, wenig auffälliges Zähnchen. Mittel- und Hintertibien gedrungener, gerade. Pygidium fein und dicht punktiert. Abdomen sehr fein und weitläufig eingestochen punktiert.

Färbung schwarz; Kopf, beim Männchen auch der Halsschild, Unterseite und Pygidium, Schildchen und Schultern metallischgrün, zum Teil auch die Schenkel metallischgrün überhaucht; Flügeldecken leuchtend blau; Fühler braun. Länge, 2.5 millimeter.

LARAT (*Muir*). British Museum of Natural History; in meiner Sammlung.

Die Vorder- und Mittelschenkel sind nur fein gezähnt, die Hinterschenkel jedoch etwas kräftiger. Beide Geschlechter haben nur einen Enddorn an den Tibien, die Vordertibien des Männchens nur einen kegelförmigen Fortsatz.

Diese Art steht *Euops aerosa* Pascoe sehr nahe. Während aber bei letzterer der Kopf dicht punktiert und zwischendurch fein punktuliert ist, ist er bei unserer Art glänzend und weitläufig punktiert ohne Zwischenpunktierung. Auch ist bei unserer Art der Halsschild kürzer und weniger deutlich quergeriefelt; die Zwischenräume der Flügeldecken weniger abfallend und aussen weniger kielartig abschliessend, auch nicht querrunzlig wie bei *aerosa* skulptiert. Die Vordertibien des Weibchens sind gedrungener gebaut.

OTIDOGNATHUS SQUAMIGER sp. nov.

Männchen.—Kopf fein und weitläufig punktiert; Stirn mit grubenförmigem Eindruck und an der schmälsten Stelle etwa ein Drittel so breit wie der Rüssel vor der Basis. Rüssel so lang wie der Halsschild, durchaus gerade, von der Fühlereinlenkung nach vorn verschmälert und an der Spitze wiederum verbreitert; im basalen Teil mit feinem Mittelkiel und feiner seitlicher Punktierung, vorn auf zwei Drittel der Länge mit einer Doppelreihe kräftiger Höckerzähne. Fühler-Schaft so lang wie die Geissel; erstes Geisselglied etwa anderthalb mal so lang wie breit; zweites Glied wenig kürzer; drittes Glied noch deutlich etwas länger als breit; viertes und sechstes Glied so lang wie breit; fünftes Glied breiter als lang. Basalglied der Fühlerkeule an der Spitze so breit wie lang. Halsschild länger als breit, von der Basis nach vorn gleichmässig gerundet verschmälert, der Vorderrand nicht zylindrisch abgesetzt. Oberseite mässig stark und dicht punktiert, jeder Punkt mit einer Gruppe Schuppen besetzt. Schildchen dreieckig, länger als breit, sparsam beschuppt. Flügeldecken von den Schultern geradlinig nach hinten verschmälert. Punktstreifen linienfömig eingerissen; Zwischenräume flach, mässig stark und dicht unregelmässig punktiert, jeder Punkt trägt eine Gruppe Schuppen. Pygidium hinten abgestutzt. Abdomen in der Mitte fein, seitlich kräftiger und dichter punktiert. Penis an der Spitze mit zwei Zähnchen.

Färbung bräunlichrot; Kopf, Rüssel, Fühler, Kniee, Tarsen, Halsschild-Oberseite und Spitze der Fügeldecken schwärzlich; Schenkel und Tibien rot. Oberseite zerstreut, Unterseite mit Ausnahme der Mitte des Abdomens dichter beschuppt. Länge, 11 millimeter.

PHILIPPINEN, Nord-Palawan, Binaluan (November bis Dezember, 1913, *Boettcher*). In meiner Sammlung.

Unter den mir bisher bekannt gewordenen Arten auffällig durch die auch oberseitige Beschuppung des Körpers. In dieser Hinsicht dürfte die Art dem *O. ursinus* Faust nahe stehen, von welcher sie sich durch spärlichere Punktierung des Kopfes, nicht ausgesprochen zweireihige Beschuppung der Interstitien, andere Färbung und geringere Grösse unterscheidet. Wie mir Herr Dr. Günther am Zoologischen Museum zu Dresden mitteilt, ist es die einzige nicht auf Neu-Guinea heimische Art, die eine derartige Schuppenbekleidung aufweist.

LAOGENIA AFFINIS sp. nov.

Rüssel gut halb so lang wie der Halsschild, fast gerade, undeutlich gebogen, zylindrisch, glänzend, sehr fein und dicht punktiert, der Rand der verstärkten Basalpartie seitlich mit einer von einer Schuppenreihe begleiteten Furche, die im Bogen zur Stirn aufläuft. Schaft kurz, den Hinterrand der Augen erreichend; erstes Geisselglied so lang wie breit; zweites Glied am längsten, doppelt so lang wie breit; die restlichen Glieder fast so lang wie breit; Basalglied der Fühlerkeule etwas breiter als lang, das tomentierte Spitzenteil halb so lang wie das Basalglied. Halsschild reichlich anderthalb mal so lang wie breit, so lang wie die Flügeldecken, parallelseitig, vorn leicht zugerundet und der Vorderrand abgeschnürt; Punktierung kräftig und sehr dicht, mit ziemlich kräftiger Mittelfurche. Schildchen undeutlich. Flügeldecken parallelseitig, hinten leicht zugerundet. Punktstreifen kräftig, furchenartig vertieft; Zwischenräume schmal kielförmig. Pygidium länger als breit, dreieckig; kräftig längsgereiht punktiert. Hinterschenkel die Spitze des Pygidiums erreichend. Unterseite und die apikale Hälfte der Schenkel kräftig und dicht punktiert. Tibien innen nicht gekerbelt.

Färbung pechbraun; Kopf, Halsschild und Schenkel fast schwarz; Flügeldecken rotbraun und ringsum dunkel gesäumt. Halsschild mit zerstreut angeordneten Schuppen besetzt, Basis des Rüssels in der Mitte und seitlich mit je einer Doppelreihe Schuppen bekleidet, die zur Stirn auflaufen, die abwechselnden Zwischenräume der Flügeldecken und die Unterseite gereiht beschuppt, die Schuppen auf den Decken kurz abstehend. Länge, 4.5 millimeter.

PHILIPPINEN, Nord-Palawan, Binaluan (November bis Dezember, 1913, *Boettcher*). In meiner Sammlung.

Der in der Grösse sehr veränderlichen *Laogenia episternalis* Heller ähnlich, an dem viel kürzeren Rüssel sofort kenntlich.

MYOCALANDRA FUSCA sp. nov.

Augen kaum vorgewölbt. Rüssel im apikalen Drittel bis Viertel stumpfwinklig abwärts gebogen, im vorderen Teil durchaus gerade und zylindrisch, hier fein gereiht punktiert; vor der Fühlereinlenkung knotenförmig verstärkt und zur Basis verjüngt, die Seiten kielartig zur Mitte der Stirn auflaufend. Fühler nur um wenig mehr als die Dicke des Schaftes von den

Augen entfernt eingelenkt. Schaft kräftig und breit, kurz, den Hinterrand der Augen erreichend; erstes Geisselglied kaum so lang wie breit; zweites Glied am längsten etwa anderthalb mal so lang wie breit; die restlichen Glieder quer. Basalglied der Fühlerkeule länger als breit; der tomentierte Spitzenteil halb so lang wie der Basalteil. Halsschild kaum länger als breit, in der basalen Hälfte parallelseitig, dann nach vorn leicht gerundet verschmälert; Vorderrand abgeschnürt; zur basis mässig und kurz gerundet verschmälert; kräftig und sehr dicht runzlig gekörnt skulptiert mit verkürztem Mittelkiel. Schildchen so lang wie breit, viereckig. Flügeldecken kaum ein und ein Viertel mal so lang wie breit, trapezförmig, seitlich undeutlich gerundet. Punktstreifen kräftig, die Zwischenräume sehr schmal. Hinterschenkel die Spitze des Pygidiums kaum überragend. Vordertibien innen gekerbt, die Mittel- und Hintertibien einfach.

Färbung einfach pechbraun. Flügeldecken und Pygidium mit kurz abstehenden Börstchen bekleidet. Länge, 37 millimeter.

PHILIPPINEN, Luzon, Limay (Oktober, 1914, *Boettcher*). In meiner Sammlung.

Der stumpfwinklig abwärts gebogene Rüssel würde die Art in die Gattung *Laocalandra* Heller verweisen, der nicht gebogene Rüssel und die innen nicht gekerbten Mittel- und Hintertibien sprechen jedoch dagegen.

ILLUSTRATION

TEXTFIGUR 1. *Auletorhinus hirtellus* gen. et sp. nov., Rüsselspitze. 523

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXIV[1]

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

THREE PLATES

The crane flies considered in this report are chiefly from the mountains of Szechwan Province, western China, where they were collected by the Rev. Mr. David C. Graham. Smaller series discussed herewith are from Formosa, collected by Mr. J. Linsley Gressitt; from Japan, by Prof. Satoru Kuwayama; and from Kashmir, by Miss Vivien R. Hutchinson. The types of the species included in the Graham material are preserved in the United States National Museum, the remaining types in my own collection. My deepest thanks are extended to the above-mentioned collectors for this continued aid in making known the vast tipulid fauna of the area in question. Two species of the allied family Trichoceridæ are described in this paper.

TRICHOCERIDÆ

TRICHOCERA RETICULATA Alexander.

Trichocera reticulata ALEXANDER, Philip. Journ. Sci. 50 (1933) 129–130.

Known hitherto only from the unique type, taken on Mount Omei, Szechwan, July 18, 1931, by George M. Franck.

Two females, Wei Chow, Szechwan, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*).

TRICHOCERA SAPPORENSIS sp. nov. Plate 1, fig. 1; Plate 2, fig. 25.

Belongs to the *maculipennis* group; general coloration of mesonotum dark brownish gray, the præscutum with four darker brown stripes; knobs of halteres dark brown; legs with femora brown, the outer ends passing into dark brown; wings yellowish subhyaline, with a heavy brown pattern, including a broken brown crossband at near midlength of the outer radial field;

[1] Contribution from the entomological laboratory, Massachusetts State College.

abdomen, including the hypopygium, dark brown; male hypopygium with the diststyle cylindrical, without basal armature.

Male.—Length, about 6.5 millimeters; wing, 7.

Rostrum dark gray; palpi black. Antennæ black throughout. Head dark brownish gray.

Mesonotal præscutum dark brownish gray, with four darker brown stripes, the intermediate pair clearly defined, separated from one another by a clear ground vitta that is more than one-half as wide as either stripe; lateral stripes broader but less clearly defined; posterior sclerites of mesonotum dark brown, pruinose. Pleura dark brown, pruinose. Halteres elongate, the stem yellow, the knob dark brown. Legs with the coxæ brown; trochanters brownish yellow; femora brown, the outer ends passing into dark brown; tibiæ and tarsi brownish black to black. Wings (Plate 1, fig. 1) with the ground color yellowish subhyaline, the costal margin more saturated; a relatively heavy brown pattern, including spots at origin of Rs, Sc_2, a stigmal area at R_2, along cord and outer end of cell 1st M_2; a spot at tip of vein 2d A in cell 1st A; an outer, more or less broken, brown band crossing the outer medial field at near midlength of the cells; veins brown. Venation: Sc_1 ending just beyond R_2; cell R_3 a little constricted just before outer end; m-cu about one-half its length before fork of M_{3+4}.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 2, fig. 25) with the mesal lobes of basistyle, *b*, contiguous on midline. Dististyle, *d*, rather short-cylindrical, without basal tubercle; mesal face with abundant delicate setulæ, distributed throughout the length.

Habitat.—Japan (Hokkaido).

Holotype, male, Sapporo, Ishikari, September, 1922 (*Kuwayama*).

The relationship of this fly to other members of the *maculipennis* group in eastern Asia is shown by the accompanying key.

Key to the species of the maculipennis group (genus Trichocera) in eastern Asia.

1. Femora brown or brownish yellow, with a subterminal brown or brownish black ring, the extreme tip pale yellow to whitish; in cases, only the posterior femora are evidently so patterned........ 2.
   Femora without a dark ring near apex, the actual tip dark........ 5.
2. Wing pattern abundantly reticulated, including a series of dots and transverse dashes in cells C, Sc_1, all outer cells, and in cells Cu and 1st A. (Western China.)........ *reticulata* Alexander.
   Wing pattern not reticulated........ 3.

3. Wing pattern light, usually without markings across outer radial field or spots in cell 2d A; dark areas not involving outer medial field; at most, a single dark spot in cell 1st A. (Western Palæarctic Region.)
maculipennis Meigen.
Wing pattern heavy, including a broken outer band that crosses the radial and medial fields; two dark spots in cell 1st A .... 4.
4. Wings with the ground color nearly hyaline; second dark spot in cell 1st A not touching vein 2d A; male hypopygium without basal tubercle on dististyle. (Himalayan Region.) .... *punctipennis* Brunetti.
Wings strongly tinged with yellow, especially along costal border; second dark spot in cell 1st A touching vein 2d A; male hypopygium with a basal tubercle on dististyle. (Western China.)
szechwanensis sp. nov.
5. General coloration of mesonotum brown; abdominal segments brown, ringed with yellow. (Formosa.) .... *arisanensis* Alexander.
General coloration of mesonotum dark gray or brownish gray; abdomen uniformly darkened or with the segments merely pruinose at outer end .... 6.
6. Male hypopygium without basal tubercle on dististyle; wing pattern heavy, in male including a band across outer radial field. (Northern Japan.) .... *sapporensis* sp. nov.
Male hypopygium with a small basal tubercle on dististyle; wing pattern light, in male without a band across outer radial field. (Japan.)
pictipennis Alexander.

I have omitted *Trichocera ocellata* Walker from the above key because of lack of data on certain of the points used in the key structure. The species should be readily distinguished from all species keyed above by the partly ocelliform nature of the wing pattern.

TRICHOCERA SZECHWANENSIS sp. nov. Plate 1, fig. 2; Plate 2, fig. 26.

Belongs to the *maculipennis* group; general coloration gray, the præscutum with four, narrow, dark brown stripes; femora brownish yellow, the tips of fore and middle femora darkened, the posterior femora with a subterminal dark ring; wings strongly suffused with yellow, heavily patterned with brown; male hypopygium with a small basal tubercle on mesal face of dististyle.

Male.—Length, about 6.5 to 7.5 millimeters; wing, 7.5 to 9.

Female.—Length, 7 to 8.5 millimeters; wing, 7.5 to 10.

Rostrum and palpi black. Antennæ with scape brownish black; pedicel more reddish brown; flagellum black. Head gray.

Mesonotal præscutum gray with four narrow and distinct dark brown stripes, the intermediate pair separated by a ground line that is nearly as wide as the stripe itself; posterior sclerites of notum gray. Pleura gray. Halteres yellow, the knobs dark

brown. Legs with the coxæ brownish gray; trochanters obscure yellow; femora brownish yellow, the tips dark brown; on posterior femora the dark rings distinctly subterminal, with narrow but conspicuous yellow tips; on fore and middle femora the dark rings are apical or virtually so; tibiæ and basitarsi light yellowish brown; outer tarsal segments passing into brownish black. Wings (Plate 1, fig. 2) with the ground color strongly suffused with yellow, more saturated in the costal portion; an unusually heavy brown pattern, including areas at origin of Rs, Sc_2, along cord and outer end of cell 1st M_2, and a broad, nearly unbroken, oblique band across the outer radial and medial fields; in cases, the latter band appears double, with pale centers; in addition to the above, a series of dark marginal spots at ends of all longitudinal veins, the largest at 2d A, contiguous with the tip of the vein; in the more heavily patterned specimens, especially females, the entire caudal border of cell 1st A is uninterruptedly darkened; in still other cases with transverse dashes in basal portions of cells R_4 and R_5, extending from near the fork of vein R_{2+3+4} to m; veins pale, darker in the clouded areas. A series of trichia at near midlength of vein 2d A, lacking at both ends. Venation: m-cu close to fork of M_{3+4}.

Abdomen dark brown, the caudal borders of segments in female narrowly paler; hypopygium dark. Male hypopygium (Plate 2, fig. 26) with the dististyle, *d*, cylindrical, on mesal face at base with a small tubercle.

Habitat.—China (Szechwan).

Holotype, male, Chengtu, altitude 1,800 feet, February 20, 1933 (*Graham*). Allotopotype, female, February 28, 1933. Paratopotypes, several males and females, February 20 to March 13, 1933; paratype, 1 male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The nearest allies of the present fly are *Trichocera pictipennis* Alexander and *T. punctipennis* Brunetti. The characters separating these species and other regional members of the group are shown by the key given in connection with the preceding species. Several of the specimens in the type series are much smaller than the holotype and allotype chosen as being representative of the species, but the entire series appears to present a single form.

TIPULIDÆ

TIPULINÆ

TIPULA (VESTIPLEX) OPTANDA sp. nov. Plate 1, fig. 3; Plate 2, figs. 27 and 28.

General coloration of mesonotum yellow, with four grayish brown stripes that are narrowly bordered by dark brown, the intermediate pair confluent at anterior ends; capillary median lines on head and on mesonotum from suture caudad to base of abdomen; knobs of halteres dark brown; femora brownish yellow, the tips blackened, preceded by a vague, more yellowish ring; wings relatively narrow, marmorate with cream-colored and darker areas; basal abdominal tergites yellow, trivittate with brown; fifth and succeeding abdominal segments black; male hypopygium with a small apical spine on basistyle; mesal appendage of basistyle black, forked at tip.

Male.—Length, about 17 millimeters; wing, 20.

Frontal prolongation of head yellow, darker laterally; nasus long and slender; palpi dark. Antennæ (male) relatively long, if bent backward extending approximately to base of abdomen; scape and pedicel yellow; first flagellar segment light brown; remaining flagellar segments black, the extreme apex of the more proximal segments a trifle paler; longest verticils very nearly equal in length to the segments. Head chiefly covered with a golden yellow pollen; central portion of posterior vertex with a conspicuous brown streak.

Mesonotal præscutum yellow with four grayish brown stripes that are narrowly bordered by dark brown, the intermediate pair confluent at anterior ends; scutal lobes with two confluent dark brown areas on outer portion; scutellum and mediotergite golden yellow; a capillary, dark brown, median vitta extends from the suture to the base of abdomen, slightly interrupted at the sutures. Pleura yellow, variegated with darker on the anepisternum. Halteres brownish yellow, the knobs dark brown. Legs long and slender; coxæ and trochanters yellow; femora brownish yellow basally, passing into black on outer two-thirds, the tips broadly black, preceded by a vague, more yellowish ring; tibiæ and tarsi black. Wings (Plate 1, fig. 3) relatively narrow; ground color brown, variegated by cream-colored and darker areas; cell Sc more darkened, pale beyond origin of Rs;

a dark mark in bases of cells R and M; a small inclosed white spot at proximal end of stigma; apical cells of wing uniformly darkened; cell 2d A variegated by pale at base and at outer end; veins dark brown. Venation: R_{1+2} entire but pale, with trichia only at extreme proximal end; cell 1st M_2 relatively long, its outer end somewhat pointed by the obliquity of m.

Abdominal tergites yellow, with a broad median stripe and much narrower, sublateral, brown stripes; fifth and succeeding segments uniformly black; basal sternites yellow. Male hypopygium (Plate 2, fig. 27) with the tergite, *9t*, fused with sternite, *9s*, on its cephalic portion. Tergite (Plate 2, fig. 28, *9t*) with the outer lobes relatively long and slender, fleshy and conspicuously setiferous, divergent; caudal margin of tergite with a broad U-shaped notch; on ventral surface of tergite, on either side, with a compressed black plate, the apex of which is microscopically serrulate. Basistyle at apex (Plate 2, fig. 28, *b*) produced into a small, slender, straight or gently curved spine, much more reduced and delicate than in most species of the subgenus; on mesal-posterior portion of basistyle a larger curved black hook; immediately above this point and apparently arising from the ninth sternite, a long, slender, curved, black rod (Plate 2, fig. 28, *m*), decussate with its mate across the median line, at apex split into two branches; outer branch a little longer than the lower one; outer margin and surface of this rod with long, delicate, pale setæ. Dististyles as shown (Plate 2, fig. 27, *id, od*). Eighth sternite unarmed with setæ.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The nearest ally of this fly is undoubtedly *Tipula* (*Vestiplex*) *parvapiculata* Alexander, of northern Formosa, which has the same reduced spine on the basistyle of the male hypopygium and with the mesal appendage of the ninth sternite of somewhat similar form though pale yellow in color. The Formosan species is separated by the much shorter antennæ, details of wing pattern, and the structure of the male hypopygium.

TIPULA (VESTIPLEX) IMMOTA sp. nov. Plate 1, fig. 4; Plate 2, fig. 29.

General coloration of mesonotum brownish yellow, the præscutum with four conspicuous brown stripes, the intermediate pair narrowly confluent in front; antennæ (male) elongate; head and posterior sclerites of mesonotum with a narrow brown

capillary vitta; wings whitish subhyaline, marmorate with pale and darker brown areas; basal abdominal segments yellow, the outer segments black; male hypopygium with the basistyle produced into a curved black spine; inner dististyle narrow, the tip obtusely rounded.

Male.—Length, 12 to 13 millimeters; wing, 13 to 15; antenna, 5 to 6.

Frontal prolongation of head yellow; nasus elongate; a narrow dark line on side of prolongation; palpi brownish black. Antennæ (male) elongate; basal three segments light yellow; flagellar segments bicolorous, the basal enlargement and adjoining portions of the individual segments dark, the remainder brownish yellow; in the paratype male the segments are more uniformly darkened, with only the outer ends of the segments restrictedly yellow. Head yellow, with a narrow, capillary, brown median vitta.

Mesonotal præscutum brownish yellow, with four conspicuous brown stripes that are not bordered by darker but are narrowly margined with clearer yellow outside the limits of the stripes; intermediate pair very narrowly confluent at anterior margin; scutal lobes brownish yellow, each with two conspicuous brown areas; scutellum and mediotergite brownish yellow, with a narrow brown median line that is narrowly interrupted on posterior portion of the scutellum. Pleura yellow, more grayish on the ventral anepisternum and sternopleurite. Halteres yellow, the knobs dark brown, their tips paler. Legs with the coxæ and trochanters yellow; femora brownish yellow, the tips conspicuously blackened, preceded by a vaguely brighter, clearer yellow annulus; tibiæ dark brown, passing into black; tarsi black. Wings (Plate 1, fig. 4) whitish subhyaline, variegated by pale brown and darker brown areas; the darker markings include major areas in bases of cells R and M, together with the stigma and a confluent cloud on anterior cord; paler brown areas cloud most of the wing disk, including the entire wing tip except a vague brightening in outer end of cell R_5; veins brown. Venation: R_3 rather strongly upcurved, a little less so in the type than in the paratype (which is figured).

Basal abdominal segments yellow, the first segment and basal ring of second tergite darkened medially; sixth and succeeding segments black. Male hypopygium (Plate 2, fig. 29) with the basistyle, *b*, entirely cut off from sternite, *9s*, by a suture; poste-

rior end of basistyle produced into an acute blackened spine that is directed caudad, dorsad, and slightly mesad. Ninth tergite, *9t*, transverse, the caudal margin with a broad U-shaped emargination, the border of this notch heavily blackened, especially the nearly acute sublateral lobes; sublateral lobes separated from paler outer lobes by small V-shaped notches; tergite not divided medially by membrane, but restrictedly paler in color at midline, and the midregion of the blackened margin with a microscopic split; caudal border of tergite with conspicuous setæ. Outer dististyle, *od*, a narrow dusky lobe with abundant coarse setæ. Inner dististyle, *id*, unusually narrow, the tip obtuse, the face with two low blackened lobes; outer margin of style with abundant erect yellow setæ.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Paratopotype, male.

The present fly is readily told from other small species of the subgenus having the basistyle produced into a simple acute spine and with the wings darkened in the proximal ends of cells R and M, by the elongate antennæ of the male and the structure of the male hypopygium, notably the undivided tergite and the narrow, obstusely pointed, inner dististyle.

TIPULA (OREOMYZA) COXITALIS sp. nov. Plate 1, fig. 5; Plate 2, figs. 30 and 31.

General coloration yellow, the præscutum with four narrow brownish stripes, the intermediate pair narrowly divided by a pale line; antennal flagellum bicolorous; tips of femora darkened; wings yellow, the prearcular and subcostal regions brighter yellow; disk of wing variegated by dark and pale brown clouds; outer end of cell 1st M_2 pointed; male hypopygium with the basistyle entire, produced caudad into a long powerful arm; a pencil of reddish setæ on either side of median line of ninth sternite.

Male.—Length, about 15 to 18 millimeters; wing, 16 to 19.

Female.—Length, 18 to 20 millimeters; wing, 16 to 18.5.

Frontal prolongation of head brownish yellow; nasus long and conspicuous; palpi dark brown, the incisures paler. Antennæ (male) of moderate length, if bent backward extending nearly to root of halteres; scape, pedicel, and first flagellar segment yellow; succeeding flagellar segments bicolorous, yellow, with the basal enlargements of the individual segments black; outer segments more obscured, but retaining the bicolorous nature to the end; longest verticils subequal in length to the segments.

Head buffy, with a very faint brown median line; posterior orbits very narrowly pale.

Mesonotal præscutum yellow, with four narrow brownish stripes, the intermediate pair narrowly separated except at extreme posterior end by a capillary pale vitta; mesal edges of anterior third of intermediate stripes a little darker than the corresponding outer edges; small brown spots in humeral area; scutum yellow, each lobe variegated by darker yellow; scutellum and mediotergite yellow with a continuous dark median vitta. Pleura yellow. Halteres yellow, the bases of knobs black. Legs with the coxæ and trochanters yellow; femora brownish yellow, the tips narrowly blackened; tibiæ slightly darker than the femora, the tips very narrowly darkened; tarsi black. Wings (Plate 1, fig. 5) yellow, the prearcular and subcostal regions clear bright yellow; cell C more infumed; stigma dark brown; extreme apical margin darkened; remainder of disk variegated by pale brown clouds, including the wing tip; small darker brown areas in bases of cells R and M, at origin of Rs, and on anterior cord, the last extending across cell R_1 to isolate a small white spot before the stigma; veins brown, yellow in the flavous areas. Macrotrichia of veins relatively numerous; squama naked. Venation: Outer end of cell 1st M_2 strongly pointed by the obliquity of vein m; petiole of cell M_1 shorter than m.

Abdomen with basal tergites yellow, narrowly trilineate with dark brown, the lateral borders paler; sternites more uniformly pale; outer segments and hypopygium more uniformly blackened. Male hypopygium (Plate 2, fig. 30) with the tergite, 9*t*, fused on cephalic third with the sternite, 9*s;* basistyle (coxite), *b*, very large and powerful, entirely cut off from the sternite, produced caudad into a long arm that is a little expanded at distal end. Ninth tergite (Plate 2, fig. 31, 9*t*) completely divided along midline by pale membrane, the lateral lobes produced into short blackened horns, ventrad of each of which lies a slightly more extensive, darkened lobe. Dististyles as figured; beak of inner dististyle (Plate 2, fig. 31, *id*) heavily blackened, the outer posterior angle produced into a gently curved lobe; on face of style near base with a much longer rod. Ninth sternite, 9*s*, near caudal end on either side of midline with a conspicuous hair pencil of reddish bristles, these pencils not arising from basal tubercles. Ovipositor with the basal shield exceeding the cerci in length.

Habitat.—Formosa.

Holotype, male, Hassensan, altitude 6,532 feet, June 26, 1934 (*Gressitt*). Allotopotype, female, altitude 4,875 feet, June 22, 1934. Paratopotype, male, altitude 6,700 feet, June 26, 1934; paratype, female, Bukai, altitude 2,775 feet, June 14, 1934 (*Gressitt*).

Among the hitherto defined regional species, I regard the present fly as being most nearly allied to *Tipula terebrata* Edwards (Formosa), which differs in the black flagellum, distinct thoracic pattern, notably the blackened confluent inner margins of the intermediate præscutal stripes, and the truncated outer end of cell 1st M_2. Both of the above are allied to the species next described, *Tipula* (*Oreomyza*) *sternotuberculata* sp. nov. I would place all of these species in the subgenus *Oreomyza* Pokorny.

TIPULA (OREOMYZA) STERNOTUBERCULATA sp. nov. Plate 1, fig. 6; Plate 2, figs. 32 and 33.

Allied to *coxitalis;* antennæ of moderate length, bicolorous; præscutum olive-yellow, with four more olive-brown stripes; tips of femora broadly black; wings brown, variegated by darker brown and cream-colored areas; outer abdominal segments black; male hypopygium with the ninth sternite on either side of median line produced into long black tubercles that are tufted with relatively short golden yellow setæ; basistyle long-produced.

Male.—Length, 13 to 15 millimeters; wing, 15 to 18.

Frontal prolongation of head obscure yellow, a little darker above; nasus distinct; palpi brown. Antennæ (male) of moderate length, if bent backward extending about to root of halteres; scape, pedicel, and first flagellar segment yellow; succeeding flagellar segments bicolorous, the basal enlargements dark brown, the outer portions obscure yellow, on outer segments passing into brown; verticils shorter than the segments. Head olive-green, more yellowish in front; no distinct dark marking on vertex.

Pronotal scutellum pale with a conspicuous, dark brown, median spot. Mesonotal præscutum olive-yellow with four more olive-brown stripes, the intermediate pair separated by a pale line throughout the entire length; scutum pale olive-yellow, variegated by slightly darker olive-yellow; scutellum and mediotergite olive-green, with a capillary brown vitta that is scarcely evident. Pleura buffy, variegated by more olive-green on ane-

pisternum and sternopleurite. Halteres infumed, the base of stem and apex of knob yellow. Legs with the coxæ buffy; trochanters yellow; femora brownish yellow, the tips broadly black, with a more or less distinct, clearer yellow, subterminal ring; tibiæ dark brown; tarsi black. Wings (Plate 1, fig. 6) with the ground color brown, sparsely variegated by darker brown and with more abundant cream-colored areas; the darker spots include the stigma, together with an adjoining area on anterior cord and a mark at origin of Rs; bases of cells R and M not or scarcely darkened; veins brown. Venation: Rs long, just exceeding R_3; cell 1st M_2 small; petiole of cell M_1 a little longer than m.

Basal abdominal tergites yellow, indistinctly trivittate with brown, the lateral margins narrowly pale; at near midlength of the organ, the stripes become heavier; outer abdominal segments, including hypopygium, black; basal sternites more uniformly yellow. Male hypopygium (Plate 2, fig. 32) with the tergite, *9t*, separated from the sternite, *9s*, by membrane, united on cephalic portion. Basistyle, *b*, long-produced, as in *coxitalis*, but of different conformation. Ninth tergite (Plate 2, fig. 33, *9t*) entirely divided medially; caudal lobes adjoining the mesal membrane clothed with long yellow setæ; ventrad of these lobes, a more-depressed blackened plate. Dististyles as figured; inner style (Plate 2, fig. 33, *id*). Ninth sternite, *9s*, on either side of median line produced into long basal tubercles that are tufted with relatively short golden-yellow setæ.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,640 feet, May 24, 1934 (*Gressitt*). Paratopotype, male, altitude 6,200 feet, May 26, 1934 (*Gressitt*).

The nearest ally of the present fly is undoubtedly *Tipula* (*Oreomyza*) *coxitalis* sp. nov., which differs most evidently in the hypopygial characters, notably the nontuberculate ninth sternite. Both species seem to be nearly allied to *T.* (*O.*) *terebrata* Edwards, the male of which is unknown.

TIPULA (OREOMYZA) RESUPINA sp. nov. Plate 1, fig. 7; Plate 2, fig. 34.

General coloration light gray, the præscutum with four dark grayish brown stripes, the intermediate pair darker in front and clearly divided by a capillary line of the ground color, becoming confluent behind; knobs of halteres infuscated; fore and middle femora black, the bases restrictedly yellow; posterior

femora yellow, the distal fourth black; tibiæ yellowish brown, the tips narrowly blackened; wings whitish subhyaline, the prearcular region and cell Sc light yellow; a sparse darker pattern on disk; R_{1+2} preserved on basal half; abdominal tergites narrowly lined medially with dark brown, the sternites more broadly so; male hypopygium with the tergite entirely pale; eighth sternite tufted with yellow setæ.

Male.—Length, about 11 millimeters; wing, 12.5.

Frontal prolongation of head brownish gray above, more sparsely pruinose on sides; nasus long and slender. Antennæ (male) of moderate length, if bent backward extending approximately to root of halteres; basal three segments clear light yellow; fourth segment yellow, with the base weakly darkened; succeeding segments bicolorous, dark basally, the remainder yellow, only the outer three or four segments more uniformly darkened; longest verticils a little shorter than the segments. Head clear ashy gray.

Mesonotal præscutum gray, with four dark grayish brown stripes, the intermediate pair darker in front and here clearly separated by a line of the ground color, converging behind and becoming confluent on posterior half; lateral stripes narrow and paling to the ground color behind; setigerous punctures of the interspaces relatively conspicuous; scutal lobes light gray, variegated by dark brownish gray areas; posterior sclerites of mesonotum light gray, the mediotergite with a linear median mark on cephalic half. Pleura light ashy gray; dorsopleural membrane pale yellow. Halteres pale yellow, the knobs infuscated. Legs with the coxæ light gray; trochanters brownish yellow; fore and middle femora black, only the bases restrictedly yellow; posterior femora obscure brownish yellow, with about the distal fourth black; tibiæ yellowish brown, the tips narrowly blackened; tarsi passing into black. Wings (Plate 1, fig. 7) with the ground color whitish subhyaline, sparsely variegated by pale brown; prearcular region and cell Sc light yellow; cell C slightly darker; stigma dark brown, confluent with a paler brown cloud on anterior cord; dark spot at origin of Rs small; outer ends of radial field darkened; longitudinal veins beyond cord, together with Cu_1 and 2d A, narrowly seamed with brown; veins brown, brighter in the flavous areas. Venation: R_{1+2} preserved on more than basal half, bent strongly backward or basad, widening the cell at margin; no macrotrichia on R_{1+2}; cell 1st M_2 relatively long and narrow.

Abdominal tergites obscure yellow, with a conspicuous dark brown median stripe that is narrowly interrupted at the posterior border of the segments; sternites chiefly dark brown, the lateral portions narrowly brightened. Male hypopygium (Plate 2, fig. 34) with the tergite, *9t*, entirely separated from the sternite; basistyle entire. Ninth tergite (Plate 2, fig. 34, *9t*) along the sides about as long as wide, narrower in the central portion, entirely pale in color; outer third narrowed, the caudal margin with a U-shaped notch; a tiny median incision, with short ridges on dorsal surface of tergite back from this point. Styli as shown, the outer dilated at outer end. Eighth sternite with an abundant brush of yellow setæ on caudal margin, those on the lateral portions longer and more conspicuous than those on median area.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The wings of the present fly are most like those of *Tipula* (*Oreomyza*) *percara* Alexander (southwestern China, in September), the latter differing in the yellow halteres, barely indicated præscutal stripes, and median dark line on head. Other generally similar regional species, including *jedoensis* Alexander, *legalis* Alexander, *mutiloides* Alexander, *pedicellaris* Alexander, and *submutila* Alexander, differ in the blackened antennal flagellum and all details of venation and of body and wing coloration.

TIPULA (OREOMYZA) EXCETRA sp. nov. Plate 1, fig. 8.

Female.—Length, 15 to 16 millimeters; wing, 15 to 15.5.

Most nearly allied to *Tipula* (*Oreomyza*) *striatipennis* Brunetti (eastern Himalayas) and *T.* (*O.*) *quadrifasciata* Matsumura (Japan), differing in colorational details, as follows:

Compared with *striatipennis:* Antennæ with basal four segments yellow, the succeeding segments brownish black; in *striatipennis* the scape and pedicel are yellow, the basal flagellar segments bright reddish brown, only the outer segments becoming darker brown. Median præscutal stripe divided on posterior half by a dusky line, the anterior ends of the intermediate stripes darkened; setigerous punctures on interspaces conspicuous; in *striatipennis,* small and inconspicuous.

Compared with *quadrifasciata:* Frontal prolongation of head, including nasus, gray; in *quadrifasciata* the nasus is abruptly

light yellow. Antennæ with basal four segments yellow; in *quadrifasciata* the basal three, with the remaining segments are dark brown. In *quadrifasciata* the median præscutal stripe behind not divided by a dusky line; scutellum with a median brown vitta that is obsolete in *quadrifasciata.*

All three species agree in having a more or less distinct median line on the gray vertex; setigerous punctures on the præscutal interspaces; legs with all femora, excepting their very narrow bases, uniformly black; wings whitish, quadrifasciate with pale brown; cell C uniformly dark brown; vein R_{1+2} with all but a basal spur atrophied.

Habitat.—China (Szechwan).

Holotype, female, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Paratopotype, female.

TIPULA (OREOMYZA) IGNOSCENS sp. nov.

Allied to *striatipennis;* mesonotal præscutum gray, with four brownish gray stripes, the intermediate pair confluent on posterior half; fore femora chiefly black, the middle and hind femora obscure yellow, with about the distal sixth blackened; wings cream-colored with four diffuse brown crossbands; prearcular region strongly suffused with yellow; cell C black; wing apex broadly darkened; vein R_{1+2} preserved as a basal spur.

Female.—Length, about 16 millimeters; wing, 15.5.

Frontal prolongation of head dark gray dorsally, the nasus concolorous; sides of prolongation brown; palpi black. Antennæ (female) relatively long, exceeding the palpi in length; flagellar segments much longer than in *excetra;* basal four segments yellow, the succeeding segments bicolorous, dark basally, the outer portion yellow; outer two or three segments more uniformly darkened; segments about as long as the longest verticils. Head gray, with a very delicate, barely indicated, capillary, dark line extending from the summit of the vertical tubercle to the occiput.

Mesonotum gray, the præscutum with four brownish gray stripes that are best indicated on their anterior ends, the intermediate pair confluent on posterior half, on anterior portion separated by a narrow gray line; setigerous punctures small; posterior sclerites of notum dark gray, the mediotergite with a central dark vitta. Pleura gray, the dorsopleural region more yellow. Halteres yellow, the knobs dark brown. Legs with the coxæ light gray; trochanters yellow; fore femora chiefly black,

the bases narrowly yellow; middle and hind femora obscure yellow, passing into brownish yellow, the tips narrowly blackened, involving only the distal sixth or approximately so; tibiæ and tarsi black. Wings much as in *excetra* but the ground color more creamy than white; posterior prearcular region strongly suffused with yellow; cell C uniformly black, much wider than in *excetra*, cell Sc correspondingly narrow; dark crossbands more extensive, encroaching on the ground color; second dark band widely expanded behind, in cell 1st A including the entire posterior border excepting a narrow space adjoining vein 1st A; wing tip more extensively darkened, restricting the post-stigmal ground area, which here embraces only about one-third the length of cell R_3, in *excetra* and allies, nearly if not quite one-half the cell; veins yellow, brown in the clouded areas. Venation: R_{1+2} preserved as a basal spur that is nearly as long as R_2 alone; m-cu at the fork of M_{3+4}.

Abdominal tergites obscure yellow, with a broad, conspicuous, black, median stripe, most evident on the basal segments, becoming narrower and the surface more pruinose on the outer segments; sternites dark, the surface pruinose. Shield of ovipositor polished chestnut; cerci long and slender, straight.

Habitat.—China (Szechwan).

Holotype, female, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

Tipula (*Oreomyza*) *ignoscens* is most closely allied to *T.* (*O.*) *striatipennis* Brunetti and allies, including the regional *excetra* sp. nov. and *latiflava* Alexander, differing especially in the pattern of the legs and wings.

TIPULA (LUNATIPULA) MULTISETOSA sp. nov. Plate 1, fig. 9; Plate 3, figs. 35 and 36.

Belongs to the *marmoratipennis* group; allied to *multibarbata;* antennal flagellum black; mesonotal præscutum light gray, with four brownish gray stripes that are narrowly bordered by dark brown; a continuous median brown vitta from the suture to base of abdomen; wings heavily marmorate with grayish brown, brown, and cream; m-cu uniting with M_{3+4} at near two-thirds the length; outer radial and medial cells of wing pale; male hypopygium with the lateral tergal lobes narrow, divergent; outer dististyle long, boomerang-shaped, with recurved black spines at tip.

Male.—Length, about 17 millimeters; wing, 19; antenna, about 5.

Frontal prolongation of head brownish yellow, darker laterally; nasus long and slender; palpi with basal three segments brown, the elongate terminal segment light yellow, its distal third darkened. Antennæ (male) moderately elongate, if bent backward extending about to root of halteres; scape and pedicel yellow, flagellum brownish black; longest verticils a little exceeding the segments. Front whitish; vertex buffy, with a conspicuous dark brown median stripe.

Mesonotal præscutum with the ground color light gray, with four brownish gray stripes that are narrowly margined with dark brown, the border not or scarcely involving the outer margin of the lateral stripes; additional brown lines on the humeral region and sublaterally before the suture; scutum gray, each lobe with two confluent brownish gray areas that are narrowly bordered by darker; posterior sclerites of mesonotum with a more golden yellow pollen; a continuous dark brown median line extending from the suture to the base of abdomen. Pleura heavily yellow pollinose. Halteres yellow, the knobs dark brown (distal ends broken in unique type). Legs with the coxæ grayish yellow; trochanters yellow; femora yellow basally, passing into brownish yellow, the tips black, preceded by a vague, yellow, subterminal ring; tibiæ and tarsi black. Wings (Plate 1, fig. 9) narrow, with long basal petiole; ground color grayish brown, heavily marmorate with cream-yellow and darker brown areas; cell Sc uniformly blackened, cell C pale yellow; a narrow darkening in bases of cells R and M; conspicuous dark clouds on anterior cord, outer end of cell 1st M_2, at midlength of outer radial field, and across cells R, M, Cu, and the anals; outer radial and medial cells chiefly pale, with restricted dark marginal clouds at ends of longitudinal veins; veins dark brown. Squama with setæ; very sparse trichia on vein R_3; a series of about a score of trichia on basal fifth of vein 1st A. Venation: R_{1+2} entire; R_3 rather strongly arcuate, slightly narrowing cell R_3; m-cu at two-thirds the length of M_{3+4}.

Basal abdominal tergites brownish yellow, the basal segments blackened sublaterally; fifth and succeeding segments uniformly blackened, the eighth sternite somewhat paler. Male hypopygium (Plate 3, fig. 35) relatively small, the ninth segment considerably reduced; tergite, *9t*, incompletely separated from the small sternite, *9s*, by a posterior incision; basistyle very small. Ninth tergite (Plate 3, fig. 36, *9t*) narrowly transverse, the caudal margin laterally produced into two slender black lobes

that are divergent and strongly upturned, the margin weakly serrulate; a low rounded lobe in the middle of the sclerite, placed farther cephalad than the lateral lobes, this cushion densely set with small black spines; behind these three lobes the narrow dorsal portion of the tergite bears long, dense, brown setæ distributed over almost the whole segment, the band of punctures narrowest on the midline. Outer dististyle (Plate 3, fig. 35, *od*) a long, gently arcuated, dark-colored rod, the apex blackened, the general shape about like a boomerang; apex of style with several recurved black spines. Inner dististyle (Plate 3, fig. 35, *id*) shorter, with heavily blackened spines at apex and at near midlength. Eighth sternite (Plate 3, fig. 36, 8*s*) large, sheathing the ninth; each lateral angle produced into a rounded knob that bears about a dozen long setæ, which are more or less decussate across the midline of body; caudal border of sternite, between the lobes, nearly straight, with a dense flat group of yellow setæ on either side of the midline.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The nearest ally of the present fly is *Tipula* (*Lunatipula*) *multibarbata* Alexander (Korea), which differs conspicuously in the wing pattern, venation, and details of the male hypopygium.

TIPULA (SCHUMMELIA) STRICTIVA sp. nov. Plate 1, fig. 10.

General coloration of mesonotum light brown, the præscutal stripes very indistinct; hind femora chiefly black, with approximately the basal third yellow; fore femora more uniformly brown; tibiæ and tarsi black; wings strongly tinged with yellow; stigma dark brown; m-cu narrowly seamed with brown; abdominal tergites yellow, the posterior and lateral margins narrowly brown.

Female.—Length, about 11 millimeters; wing, 11.8.

Frontal prolongation of head relatively short, yellowish brown; palpi dark brown. Antennæ (female) with the basal three segments yellow; succeeding flagellar segments bicolorous, yellow, with the basal enlargements conspicuously black; outer flagellar segments more uniformly infumed; longest verticils unilaterally distributed, in female exceeding the segments in length. Front whitish pruinose; posterior portion of head brown.

Mesonotum light brown, the præscutal stripes very indistinct, the intermediate pair vaguely bordered by narrow darker

lines, a capillary median vitta being somewhat more evident; mediotergite sparsely pruinose. Pleura yellow. Halteres yellowish brown. Legs with the coxæ and trochanters pale yellow; femora chiefly black, the basal third or thereabouts paler; fore femora more uniformly brown; tibiæ and tarsi black. Wings (Plate 1, fig. 10) with a strong yellow tinge, the prearcular field and cell Sc more intense, clearer yellow; cell C, anterior portion of cell R and outer radial field more infumed; stigma long-oval, dark brown, preceded and followed by restricted clear yellow areas; outer medial veins, m-cu, and distal section of Cu_1 narrowly seamed with brown; veins yellow, darker in the clouded portions of the medial field. No macrotrichia in cells of wing. Venation: R_{1+2} entire but pale, with trichia at proximal end only; R_2 subequal to R_1; cell 1st M_2 small.

Abdominal tergites yellow, the posterior and lateral margins narrowly brown; sternites more uniformly light yellow. Cerci straight and very slender.

Habitat.—Formosa.

Holotype, female, Taiheizan, altitude 5,500 feet, July 8, 1934 (*Gressitt*).

Tipula (*Schummelia*) *strictiva* is most nearly alied to *T.* (*S.*) *rantaicola* Alexander, likewise of Formosa, differing in the chiefly blackened femora and the strongly yellow wings.

TIPULA SINDENSIS sp. nov. Plate 1, fig. 11; Plate 3, fig. 37.

Belongs to the *thibetana* group; allied to *griseipennis;* size small (wing, 13.5 to 14 millimeters); antennal flagellum dark brown; mesonotal præscutum light gray, with three darker gray stripes, the median one narrowly and conspicuously bordered by darker brown; femora brownish yellow, the tips narrowly blackened; wings pale grayish brown, tesselated with slightly darker brown and cream-colored areas; cell 1st M_2 long; abdominal tergites orange-yellow, with a conspicuous dark brown stripe on either side.

Male.—Length, about 13 to 13.5 millimeters; wing, 13.5 to 14.

Frontal prolongation of head relatively elongate, dark gray; nasus very small; palpi black. Antennæ with scape brownish yellow; pedicel a little clearer yellow; flagellar segments uniformly dark brown; verticils shorter than the segments. Head brownish gray.

Pronotum gray, variegated with brown medially and on the sides. Mesonotal præscutum light gray, with three darker gray

stripes, the median one narrow and conspicuously bordered for its whole length by dark brown, and very faintly and inconspicuously split medially by a dusky vitta; lateral stripes with a dark spot at cephalic end; scutal lobes light gray, variegated by dark areas; posterior sclerites of mesonotum gray. Pleura gray, the dorsopleural membrane more dusky. Halteres pale, the base of stem restrictedly pale, the knobs infuscated. Legs with the coxæ gray; trochanters obscure yellow, weakly pruinose; femora brownish yellow, the tips narrowly blackened; tibiæ yellowish brown, the tips passing into black; tarsi black, the proximal ends of basitarsi paler. Wings (Plate 1, fig. 11) pale grayish brown, tesselated with slightly darker brown and cream-yellow areas, the pattern arranged much as in *griseipennis;* veins dark brown. Venation: R_3 variable in its course, in the type rather strongly upcurved at outer end, in paratype more nearly straight; posterior medial and cubital veins bent basad at margin; cell 1st M_2 long, cell M_1 relatively short.

Abdomen with basal tergite dark brownish gray, restrictedly variegated by pale; succeeding tergites orange-yellow, with broad, conspicuous, sublateral, brown stripes that are slightly interrupted at the posterior borders; extreme lateral margins of tergites grayish pruinose; sternites orange-yellow, darker laterally; subterminal segments brownish black, the styli yellow. Male hypopygium with the styli of peculiar conformation, as shown by the figure (Plate 3, fig. 37, *id, od*).

Habitat.—Kashmir.

Holotype, male, Sind Valley, altitude 7,000 feet, June 11, 1934 (*Miss Hutchinson*). Paratopotype, male.

The nearest ally of the present fly seems to be the larger *Tipula griseipennis* Brunetti, which is from the Garhwal District of India. In addition to the major size, the latter species differs especially in the bicolorous antennæ, the different pattern of the præscutum and abdomen, and the structure of the male hypopygium.

Genus DOLICHOPEZA Curtis

Dolichopeza CURTIS, British Entomology (1825) 62.

Subgenus SINOROPEZA subgenus novum

Characters as in *Oropeza* Needham, differing especially in the venation of the medial field of the wing. Wing (Plate 1, fig. 12) with Sc relatively long, Sc_2 ending just before fork of Rs; tip of R_{1+2} entirely atrophied, R_2 meeting R_1 at a strong angle;

Rs straight, oblique, a little longer than the basal section of R_{4+5}; cell 1st M_2 open by atrophy of basal section of vein M_3; cell 2d M_2 petiolate; cell 1st M_2 confluent with cell M_3; second section of vein M_{1+2} subequal to basal section of M_2; m-cu more than its own length before departure of vein M_{3+4}. Subgenotype with numerous strong macrotrichia in cells Sc_2 to M_3, inclusive, these lacking in *postica.*

Type of subgenus.—Dolichopeza (*Sinoropeza*) *pluricoma* sp. nov. (Eastern Palæarctic Region: Western China.)

I am referring here also *Dolichopeza postica* Brunetti (eastern Himalayas), which has an almost identical venation but lacks the macrotrichia in the cells of the wing. The venation is quite unique in the entire family Tipulidæ in that cell 2d M_2 is long-petiolate by the presence of a basal section of vein M_2, producing the appearance of a posterior fork in the outer medial field.

DOLICHOPEZA (SINOROPEZA) PLURICOMA sp. nov. Plate 1, fig. 12.

General coloration of thoracic notum dark brown, the præscutum with three more reddish brown stripes; wings strongly tinged with dusky, the stigma darker; macrotrichia in outer ends of cells Sc_2 to M_3, inclusive.

Female.—Length, about 8 millimeters; wing, 10.

Rostrum and palpi dark brown. Antennæ dark brown throughout; basal flagellar segment (female) very long, approximately equal in length to the succeeding two and one-half segments; verticils much shorter than the segments. Head dark brown.

Mesonotum dark brown, the præscutum with three slightly brighter, more reddish brown stripes; posterior sclerites of mesonotum and the pleura rather uniformly dark brown. Halteres dusky, the extreme base of stem brightened. Legs with the coxæ dark brown; trochanters obscure yellow; femora obscure yellow basally, the tips passing into brownish black; tibiæ and basitarsi brown, the tips brownish black; outer tarsal segments black. Wings (Plate 1, fig. 12) with a strong dusky tinge; stigma oval, dark brown; a restricted brown cloud on anterior cord; veins R_{4+5}, Cu_1, and 2d A narrowly seamed with brown; pale areas before and beyond the stigma poorly defined; veins and macrotrichia dark brown. Macrotrichia in outer radial and medial cells of wing (shown in figure by stippled dots), beginning as single lines in the more basal portions of the cells, becoming more numerous and crowded in the outer portions. Venation as

discussed under the characterization of the subgenus; cell 2d A relatively wide.

Abdomen brown, the incisures somewhat darker. Ovipositor with all but the extreme bases of valves broken, but from what remains apparently of somewhat peculiar structure.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 25, 1933 (*Graham*).

The species needs comparison only with *Dolichopeza* (*Sinoropeza*) *postica* Brunetti, which is readily told by the glabrous cells of the wing.

CYLINDROTOMINÆ

CYLINDROTOMA AURANTIA sp. nov. Plate 1, fig. 13.

Entire thorax fiery orange; legs black, the extreme bases of femora obscure yellow; wings strongly suffused with black, cells C and Sc a little darker; abdomen with basal tergite yellow, the remainder of abdomen black.

Female.—Length, about 10 to 10.5 millimeters; wing, 9.5 to 10.

Rostrum and palpi black. Antennæ black throughout. Head black, the anterior vertex and posterior orbits obscure yellow; anterior vertex unusually wide.

Entire thorax, including notum and pleura, fiery orange, unmarked. Halteres black, the base of stem restrictedly yellow. Legs with the coxæ and trochanters orange; femora black, the extreme bases obscure yellow; remainder of legs black. Wings (Plate 1, fig. 13) strongly suffused with black, cells C and Sc a little darker; stigma relatively small, still deeper black; no further darkenings at origin of Rs or along cord; veins black. Venation: m-cu more than its length beyond fork of M; petiole of cell M_1 short, much less than m.

Abdomen with basal tergite yellow; remainder of abdomen, including the genital segments, black, the outer segments weakly pruinose.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 24, 1933 (*Graham*). Paratype (sex?), Wei Chow, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*).

Cylindrotoma aurantia is most nearly allied to *C. rufescens* Edwards (Tibet), differing very conspicuously in the entirely orange thorax and, beyond the basal segment, the entirely black

abdomen. The black legs are much as in the otherwise distinct *C. nigripes* Alexander (Szechwan-Tibet border). It should be noted that the wings of the type appear to be stained or discolored with a bluish or purplish tinge that does not show in the broken paratype and is undoubtedly abnormal for the species.

LIMONIINÆ

LIMONIINI

LIMONIA (LIBNOTES) IMMETATA sp. nov. Plate 1, fig. 14; Plate 3, fig. 38.

Allied to *familiaris;* antennæ black, the flagellar segments with unusually long verticils; head plumbeous gray; eyes virtually contiguous on vertex; mesothorax uniformly light orange-yellow, the mesonotum unmarked; knobs of halteres infuscated; wings whitish, the prearcular and costal regions yellow; a restricted brown pattern; Sc_1 long; male hypopygium with the tergal lobes bearing long setæ.

Male.—Length, about 8.5 millimeters; wing, 9.5.

Rostrum brownish yellow; palpi black. Antennæ black throughout, the scape a little pruinose; flagellar segments long-oval to subcylindrical, the longest verticils of unusual length, between three and four times as long as the segments; terminal segment elongate, narrowed at tip, approximately one-half longer than the penultimate. Head dark plumbeous gray; anterior vertex reduced to a mere strip or with the eyes actually contiguous.

Pronotum brown. Mesonotum uniformly light orange-yellow, unmarked, the pleura a little more yellowish. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters pale yellow; femora yellow, the tips weakly darkened; tibiæ and tarsi obscure yellow, the outer tarsal segments dark brown. Wings (Plate 1, fig. 14) whitish, the prearcular region and cells C and Sc clearer yellow; a sparse brown pattern, including the stigma; a large area at origin of Rs and smaller marks at arculus; wing tip in outer radial field vaguely darkened; a very restricted dark seam on cord, more evident at the fork of Rs; narrow clouds along vein Cu and as a marginal seam to just beyond vein Cu_1; veins dark brown, brighter in the flavous areas. Venation: Sc long, Sc_1 ending beyond r-m, Sc_2 some distance from its tip, just beyond fork of Rs, Sc_1 exceeding one-half the length of Rs; outer radial veins strongly decurved towards outer ends; cell 1st M_2 relatively small; m-cu not far beyond fork of M, subequal to the distal section of Cu_1; anal veins gently divergent.

Abdominal tergites dark brown, narrowly paler on lateral borders; sternites brownish yellow; hypopygium yellow. Male hypopygium (Plate 3, fig. 38) with the tergite, *9t*, long, the caudal margin with a broad U-shaped notch, the lateral lobes with long conspicuous setæ that are virtually lacking elsewhere on tergite. Ventral dististyle, *vd*, fleshy, the rostral prolongation blackened, with two spines of very unequal size, the inner one a mere seta. Gonapophyses, *g*, with mesal-apical lobe slender, blackened, the inner or concave margin with microscopic spines.

Habitat.—Formosa.

Holotype, male, Rokki, altitude 1,000 feet, May 17, 1934 (*Gressitt*).

The present species is allied to *Limonia* (*Libnotes*) *clitelligera* (Alexander), likewise of Formosa, differing especially in the coloration of the thorax. By Edwards's key to the species of *Libnotes*[2] the fly runs to couplet 57, disagreeing with all species beyond this point in the immaculate mesonotum.

LIMONIA (LIMONIA) TUTA sp. nov. Plate 1, fig. 15.

General coloration of mesonotum brown medially, paling to yellow on sides; knobs of halteres darkened; legs brownish yellow, the outer tarsal segments darkened; wings with a faint brown tinge, the short-oval stigma darker brown; cell 1st M_2 open by the atrophy of basal section of vein M_3; abdominal tergites dark brown; cerci slender, gently upcurved to the acute tips.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi pale brown, greatly reduced. Antennæ with scape and pedicel black; flagellum broken. Head dark gray; eyes contiguous on anterior vertex.

Pronotum brownish black. Mesonotal præscutum brown medially, obscure yellow on sides, the extreme lateral border of sclerite darkened before the suture; scutal lobes dark brown, the median area pale; scutellum and mediotergite yellowish brown. Pleura yellow, with a conspicuous, dark brown, longitudinal stripe extending from the propleura across the anepisternum, pteropleurite, and pleurotergite to the base of abdomen; dorsopleural membrane obscure yellow; sternopleurite clearer yellow. Halteres pale, the knobs darkened. Legs with the coxæ

[2] Journ. Fed. Malay St. Mus. 14 (1928) 74–80.

pale yellow, the fore coxæ a trifle more darkened; trochanters yellow; remainder of legs pale brownish yellow, the outer tarsal segments brown. Wings (Plate 1, fig. 15) with a faint brown tinge, the short-oval stigma darker brown; veins brown. Macrotrichia of veins beyond origin of Rs relatively long and conspicuous; a restricted series of trichia at outer ends of both anal veins. Venation: Sc_1 ending shortly beyond midlength of Rs, Sc_2 a short distance from its tip; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 open by the atrophy of basal section of vein M_3; m-cu close to fork of M, considerably exceeding the distal section of Cu_1; anal veins at origin nearly parallel.

Abdominal tergites dark brown, the sternites somewhat paler. Cerci slender, gently upcurved to the acute tips, exceeding the hypovalvæ in length.

Habitat.—Formosa.

Holotype, female, Hassensan, altitude 4,900 feet, June 27, 1934 (*Gressitt*).

Limonia (*Limonia*) *tuta* is very different from other regional species in having cell 1st M_2 of the wings open by the atrophy of the basal section of vein M_3. This is a very uncommon feature in the entire genus. The Philippine *L.* (*L.*) *bagobo* Alexander, which has a somewhat similar venation, is in all other regards a very different fly.

LIMONIA (RHIPIDIA) SYNSPILOTA sp. nov. Plate 1, fig. 16; Plate 3, fig. 39.

Belongs to the *maculata* group; general coloration gray, the præscutum with a brown median stripe; antennæ (male) with nine bipectinate flagellar segments; wings whitish, with an abundant gray dotting in cells; a heavier costal pattern, the area at tip of Sc and origin of Rs common; Sc relatively short; male hypopygium with the rostral prolongation of the ventral dististyle with two long slender spines close to extreme tip.

Male.—Length, about 7 millimeters; wing, 8.

Female.—Length, 7.5 to 8 millimeters; wing, 8.5 to 9.

Rostrum and palpi dark brown. Antennæ (male) black, the apical pedicels of flagellar segments whitish; flagellar segments two to ten, inclusive, bipectinate, the longest branches more than twice the segments; branches of flagellar segment two a little exceeding the segments; branches of flagellar segment ten relatively short, somewhat unequal in length; flagellar segment eleven with a single branch that is about as long as the segment;

terminal segment simple; in female, flagellar segments long-oval. Head dark gray.

Mesonotal præscutum gray, with a brownish median stripe that does not quite reach the suture; remainder of notum gray, the scutal lobes variegated with darker. Pleura dark gray. Halteres pale yellow. Legs with the coxæ brownish gray, paler at tips; trochanters yellow; femora yellow, the tips conspicuously dark brown; tibiæ and basitarsi yellow, the tips narrowly and weakly darkened; outer tarsal segments passing into black. Wings (Plate 1, fig. 16) whitish, all cells with numerous pale gray clouds; a series of four larger and darker costal areas, the third a common one over the tip of Sc and origin of Rs; cord and outer end of cell 1st M_2 seamed with grayish brown; a large rounded spot at outer end of vein 2d A; veins pale, darker in the clouded areas. Venation: Sc short, Sc_1 ending about opposite one-fourth to one-fifth the length of Rs, Sc_2 near its tip; a supernumerary crossvein in cell Sc; m-cu some distance before the fork of M.

Abdomen dark brown, the sternites in male slightly paler. Male hypopygium (Plate 3, fig. 39) with the tergite, *9t*, transverse, narrowed posteriorly, its caudal margin very gently emarginate. Basistyle, *b*, with a single simple ventromesal lobe. Ventral dististyle, *vd*, fleshy, the rostral prolongation with two long slender spines placed almost at extreme tip, these spines subequal in length to the prolongation itself, the outer spine a trifle longer than the inner. Gonapophyses, *g*, with the mesal-apical lobe simple, the tip blackened, acute.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 8,000 feet, May 26, 1934 (*Miss Hutchinson*). Allotopotype, female, pinned with type. Paratopotypes, 1 female, pinned with type; 1 female, May 22, 1934; 1 female, altitude 9,000 feet, June 3, 1934.

The present fly is closest to *Limonia* (*Rhipidia*) *subtesselata* (Brunetti) and *L.* (*R.*) *antennata* (Brunetti), being readily told by the nature of the pectinations of the antennæ and the bispinous rostral prolongation of the male hypopygium. Both Brunetti's description and Bagchi's figure of the antenna of *antennata* indicate that all twelve of the flagellar segments are bipectinate, a condition that if true is unique in the genus. Edwards's

rediscussion of the type[3] makes no mention of the antennal characters but merely compares the fly with *subtesselata*.

DICRANOPTYCHA VULPES sp. nov. Plate 1, fig. 17.

General coloration of thorax light yellowish brown, without markings; antennal scape and pedicel yellow, flagellum black; legs yellow, the outer tarsal segments brownish black; wings uniformly suffused with bright fulvous; Rs subequal in length to cell 1st M_2.

Female.—Length, 9 to 10 millimeters; wing, 9.5 to 10.5.

Rostrum brown; palpi dark brown. Antennæ with scape and pedicel yellow, flagellum black; segments subcylindrical, with verticils that exceed the segments in length. Head brown, sparsely yellow pollinose.

Mesonotum and pleura uniformly light yellowish brown, without markings. Halteres pale throughout. Legs with the coxæ and trochanters yellow; femora yellow, a little brighter on basal portion; tibiæ and basitarsi yellow, the tips of latter and succeeding segments brownish black. Wings (Plate 1, fig. 17) uniformly suffused with bright fulvous, the veins slightly more brownish yellow. Venation: Rs subequal in length to cell 1st M_2; m-cu a little less than its length beyond fork of M.

Abdominal tergites obscure yellow medially, bordered laterally with brown; sternites yellow, more or less darkened medially.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 18 and 19, 1933 (*Graham*). Paratopotypes, 2 females, August 18 to 25, 1933.

Dicranoptycha vulpes is very different from all other regional described species in the bright fulvous color of the wings, which is almost exactly like that of the larger Eastern Nearctic *D. germana* Osten Sacken, type of the genus. The genus *Dicranoptycha* is new to the fauna of China.

PEDICIINI

NIPPONOMYIA SZECHWANENSIS sp. nov. Plate 1, fig. 18; Plate 3, fig. 40.

Mesonotum reddish brown, unmarked; legs yellow; wings with a faint brownish yellow tinge, with the usual yellow, brown-margined costal pattern; no black costal dashes; cell 1st M_2 closed; m transverse; male hypopygium with the dististyle having only three or four spines.

[3] Rec. Indian Mus. 26 (1924) 297.

Male.—Length, about 11 millimeters; wing, 12.

Rostrum and palpi brownish black. Antennæ brownish yellow, with only the outer flagellar segments slightly darker. Head brownish yellow, the vertex sparsely pruinose.

Mesonotum reddish brown, the surface subnitidous; præscutum without black markings as is the case in all other regional members of the genus; central portion of præscutum, on anterior half, a little infumed. Pleura yellow. Halteres yellow throughout. Legs yellow, the terminal two tarsal segments dark brown. Wings (Plate 1, fig. 18) with a faint brownish yellow tinge, with the usual yellow, brown-margined costal pattern of the genus; costal cell without black transverse lines; outer radial field darkened; very narrow brown seams at origin of Rs, along cord, at fork of Rs, and on crossvein m; veins dark brown. Venation: r-m about its own length before the fork of Rs, the latter branching almost simultaneously into three; R_{2+3} perpendicular at origin, lying most closely to R_1 at bend and again at fork; cell R_4 widest just beyond midlength; m present, transverse.

Abdominal segments bicolorous, the basal ring darker just beyond its proximal end, the outer end and incisures pale. Male hypopygium (Plate 3, fig. 40) with the dististyle, *d*, terminating in only three or four spines.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The genus *Nipponomyia* had not before been recorded from China. *Nipponomyia szechwanensis* is very different from the other known species. The unmarked mesonotum is much like that found in *flavicollis*, but in all other respects the two flies are entirely different. The known species of the genus may be separated by means of the accompanying key.

Key to the species of Nipponomyia Alexander.

1. Thoracic dorsum without black spots on mesonotal præscutum and scutum .... 2.
   Thoracic dorsum with polished black spots on præscutum and scutum.. 3.
2. Tips of femora and tibiæ narrowly darkened; wings with the yellow costal pattern pale, interrupted by four or five large brown areas. (North Borneo.) .... *flavicollis* Edwards.
   Femora and tibiæ uniformly yellow; wings with yellow costal pattern deep and conspicuous, interrupted only by small, inconspicuous spots. (Western China.) .... *szechwanensis* sp. nov.

3. A series of black transverse dashes in costal cell of wing........................ 4.
   Costal cell of wing without black dashes.. 6.
4. Wings with cell 1st M_2 open by atrophy of m; dististyle of male hypopygium with about twelve black spines. (Japan.)
   kuwanai (Alexander).
   Wings with cell 1st M_2 normally closed; dististyle of male hypopygium with only two or three black spines.................................. ... . 5.
5. Legs yellow; wings with m transverse. (Formosa.)
   symphyletes (Alexander.)
   Legs with tips of femora and tibiæ blackened, wings with m present or lacking; when present, very oblique in position, ending almost at tip of vein M_3. (Northern India.).... *novem-punctata* (Senior-White).
6. Legs yellow; a series of about nine small black spots on mesonotal præscutum and scutum; wings without large dark clouds at Sc_2, origin of Rs, and tip of vein 2d A; m very oblique, its outer end lying far out on vein M_3. (Japan.)................................. *trispinosa* (Alexander).
   Legs with femora tipped with brown; mesonotal præscutum with two large black areas at posterior end; scutum almost uniformly black; wings with large dark clouds at Sc_2, origin of Rs, and tip of vein 2d A; m slightly oblique, shorter than the distal section of vein M_3. (Sumatra.) .... *sumatrana* (de Meijere).

ULA COMES sp. nov. Plate 1, fig. 19.

Mesonotum brownish black, sparsely pruinose; antennæ elongate, flagellum black; pleura and pleurotergite variegated black and yellow; wings yellow, heavily patterned with brown; cell 1st M_2 unusually large, subequal in length to vein M_4; abdominal tergites, including the genital shield, black.

Female.—Length, about 7 millimeters; wing, 8.

Rostrum brown; palpi brownish black. Antennæ elongate; scape and pedicel yellow, flagellum black; flagellar segments cylindrical, the longest verticils a little exceeding the segments. Head gray.

Mesonotal præscutum brownish black, sparsely pruinose; scutum and scutellum more pruinose; mediotergite brownish gray. Pleura with the anepisternum and sternopleurite brownish gray, the pteropleurite and pleurotergite yellow, the latter lined with black on the more ventral portions adjoining the root of halteres. Halteres yellow, the knobs dark brown. Legs with the coxæ yellow; trochanters yellow; femora brownish yellow, the tips narrowly dark brown; tibiæ brownish yellow, the tips narrowly brownish black; tarsi black. Wings (Plate 1, fig. 19) yellow, the stigmal area clearer yellow; an unusually heavy brown pattern, including spots at origin of Rs, Sc_2 and R_2 and seams along cord and outer end of cell 1st M_2; restricted dusky clouds at ends of outer radial veins; wing apex very narrowly bordered

with brown; narrow dusky washes along vein M and along both anal veins, that at 2d A not quite touching the vein; dark seam at cord entirely crossing wing from Sc_1 to Cu_1; veins brown, somewhat darker in the clouded areas. Macrotrichia of cells abundant (in figure, represented by stippled dots). Venation: r-m connecting with Rs at its fork, in alignment with R_5; cell 1st M_2 unusually long, subequal to vein M_4; m-cu shortly beyond fork of M.

Abdominal tergites black; sternites obscure brown, the outer segments blackened; genital shield chiefly black; cerci strongly upcurved, compressed, brownish black; hypovalvæ white.

Habitat.—China (Szechwan).

Holotype, female, Wei Chow, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*).

Ula comes is most generally similar to *U. superelegans* Alexander (Formosa), which has a somewhat similar heavy wing pattern but with the details distinct, and with cell 1st M_2 much smaller, in length not exceeding two-thirds vein M_4. The genus is new to the Chinese Republic.

HEXATOMINI

EPIPHRAGMA (EPIPHRAGMA) BICINCTIFERA sp. nov. Plate 1, fig. 20; Plate 3, fig. 41.

Mesonotal præscutum dark brown, with four reddish brown stripes on the anterior part of sclerite; antennæ relatively long; femora yellow, each with two conspicuous black rings, remainder of legs yellow; wings whitish, with a buffy brown pattern that is bordered by darker brown; m-cu a little more than one-half its length beyond the fork of M; male hypopygium with the interbase long and filiform.

Male.—Length, about 11 to 12 millimeters; wing, 11 to 12.

Female.—Length, about 10 millimeters; wing, 11.

Rostrum brown above, paler laterally; palpi black. Antennæ with the scape dark brown; pedicel a little paler; first flagellar segment yellow, succeeding segments dark brown, with long conspicuous verticils that exceed the segments. Head deep brown, the front and posterior orbits obscure yellow, the latter with a silvery pruinosity.

Mesonotal præscutum dark brown, with four reddish brown stripes in front and at midlength of the segment; posterior third or more of sclerite more uniformly dark brown; posterior margins of præscutum, behind the pseudosutural foveæ, darker brown; scutal lobes chiefly dark brown; scutellum dark brown;

mediotergite dark brown laterally and on posterior portion, the anterocentral portion gray pruinose. Pleura obscure brownish yellow, narrowly lined longitudinally with brown, including a more-dorsal stripe from the propleura to the base of halteres, and a more-ventral area including the ventral sternopleurite and meron. Halteres obscure yellow, the base of stem and apex of knob pale. Legs with the coxæ and trochanters pale; femora yellow, each with two conspicuous black rings, the first immediately distad of midlength, the second subapical, a trifle wider than the yellow apex; tibiæ and tarsi yellow, only the last tarsal segment darkened. Wings (Plate 1, fig. 20) whitish, with a handsome buffy brown pattern that is bordered by darker brown, the areas in the cubital and anal cells more solidly brown; seam on supernumerary crossvein in cell C isolated from other dark markings; the pattern is much as in *ornatipennis* (Brunetti), as figured by Brunetti,[4] but the dark areas beyond cord more broken. Venation: r-m variable in length, from very short (as shown) to normal; m-cu a little more than one-half its length beyond fork of M.

Abdominal tergites dark brown, the caudal borders narrowly yellow; sternites yellow, a little infumed at the incisures; hypopygium brownish black. Male hypopygium (Plate 3, fig. 41) with the outer dististyle, *od*, relatively long and slender. Interbase, *i*, a long, slender, filiform rod, the surface smooth, without transverse or oblique grooves on surface near tip, as is the case in *subinsignis* and allies.

Habitat.—China (Szechwan).

Holotype, male, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 27, 1933 (*Graham*). Allotopotype, female, September 1, 1933. Paratopotype, male, August 18, 1933.

Epiphragma (*Epiphragma*) *bicinctifera* is very different from other regional species of the genus in the conspicuously biannulate femora. It is most generally similar to species such as *E.* (*E.*) *subinsignis* Alexander, but amply distinct in the coloration and details of structure of the male hypopygium. The genus *Epiphragma* had not been recorded from China.

Genus GRAHAMOMYIA novum

Palpi 4-segmented. Antennæ 16-segmented, all segments distinct; outer flagellar segments gradually smaller, the last longer

[4] Rec. Indian Mus. 15 (1918) pl. 7, fig. 5, as *Limnophila.*

than the penultimate. Anterior vertex relatively wide, approximately twice the diameter of the scape. Tuberculate pits and pseudosutural foveæ lacking. Tibial spurs small but distinct. Wings (Plate 1, fig. 21) with Sc long, Sc_1 ending some distance beyond fork of Rs, Sc_2 not far removed from its tip; R_2 lacking; petiole of cell R_3 subequal in length to the cell; a supernumerary crossvein at about its own length beyond origin of vein R_4, connecting this vein with vein R_5, forming a closed cell 1st R_4 that is very similar in size and outline to cell 1st M_2; basal section of R_5 more or less reduced; Rs long, square and long-spurred at origin; cell M_1 lacking; m-cu at or before midlength of M_{3+4}; anterior arcullus broken. Male hypopygium (Plate 3, fig. 42) massive, cylindrical, the tergite, *9t*, and sternite, *9s*, fused, the basistyle, *b*, incompletely separated from the sternite by a suture, the general structure of the hypopygium not unlike that of the tipuline crane flies. Ovipositor with the cerci and hypovalvæ subequal in length and of approximately similar form, the margins of both valves entire.

Genotype.—Grahamomyia bicellula sp. nov. (Palæarctic Region: Western China.)

I take very great pleasure in dedicating this new group of crane flies to the collector of the type species, the Rev. Mr. David C. Graham, who has added very materially to our knowledge of the tipulid fauna of western China. The nearest ally is undoubtedly *Phyllolabis* Osten Sacken, which differs especially in the venation and different structure of the male hypopygium. The presence of a supernumerary crossvein in cell R_4, connecting veins R_4 and R_5 to form a second closed or discal cell, 1st R_4, is quite unique in the entire family Tipulidæ. It is approached only by *Cyttaromyia* Scudder, a cylindrotomine genus, which has a supernumerary crossvein in cell R_5, connecting posteriorly with vein M_1 to form a second discal cell, 1st R_5, immediately cephalad of and in contact with the normal cell, 1st M_2. The location of the supernumerary crossvein in cell R_4, forming cells 1st R_4 and 2d R_4, is quite as in the lower brachycerous dipteron families where this condition occurs (certain Asilidæ, Nemestrinidæ, and Bombyliidæ), as discussed in another paper.[5]

[5] Alexander, C. P., A comparison of the systems of nomenclature that have been applied to the radial field of the wing in the Diptera, Proc. IV. Internat. Congress Ent. for 1928 2 (1929) 700–707, 3 pls.

GRAHAMOMYIA BICELLULA sp. nov. Plate 1, fig. 21; Plate 3, fig. 42.

General coloration of thorax yellow; abdomen yellow, the outer segments black; femora black, tibiæ brown; wings strongly tinged with yellow.

Male.—Length, about 7.5 millimeters; wing, 8.5 to 9.

Female.—Length, about 7.5 millimeters; wing, 10.

Rostrum and palpi dark brown. Antennæ dark brown throughout. Head dark brownish gray.

Pronotum and mesonotum almost uniformly yellow, the præscutum in front slightly more brownish yellow. Pleura yellow, the ventral sternopleurite brownish black, sparsely pruinose. Halteres pale yellow, the apices of the knobs weakly darkened. Legs with the fore and middle coxæ weakly darkened, the posterior coxæ yellow; trochanters yellow; femora black; tibiæ brown, the fore pair much darker than the posterior tibiæ; tarsi black. Wings (Plate 1, fig. 21) strongly tinged with yellow, the stigmal area clearer yellow, faintly encircled by dusky; virtually all longitudinal veins very narrowly bordered by dusky, especially 2d A; veins dark, C and Sc yellow. Venation as discussed under the genus.

Abdomen (male) with basal seven segments chiefly light yellow; remaining segments, including the massive hypopygium, black. In the female, the outer three segments blackened; ovipositor with yellow valves. Male hypopygium (Plate 3, fig. 42) unusually large and massive, the ninth segment appearing as a blackened cylinder, with the tergite and sternite fused; basistyle deeply embedded in the sternite, the suture not clear, but indicated by an impressed line; caudal margin of tergal region emarginate. A semipendant fleshy lobe, *m*, from the membrane at ventral suture of the basistyle.

Habitat.—China (Szechwan).

Holotype, male, Wei Chow, 65 miles northwest of Chengtu, altitude 15,200 feet, August 14, 1933 (*Graham*). Allotopotype, female, altitude 9,000 to 12,500 feet, August 15, 1933. Paratopotype, male, with the allotype.

The further unique characters of this insect have been discussed under the generic characterization.

ERIOPTERINI

CRYPTERIA SPECTRALIS sp. nov. Plate 1, fig. 22; Plate 3, fig. 43.

General coloration almost white; antennal scape and pedicel dark brown, flagellum white; præscutum with a dark brown pat-

tern; legs white, the tips of the femora and tibiæ conspicuously brownish black; sclerites of leg with long, conspicuous, erect setæ; wings whitish subhyaline, with a restricted but very conspicuous dark brown pattern; Rs nearly square at origin; abdomen yellowish white, the genital segment and a spot on tergite four black.

Male.—Length, 5 to 5.5 millimeters; wing, 7 to 7.5.

Female.—Length, 6 to 6.5 millimeters; wing, 7 to 7.5.

Rostrum and palpi dark brown. Antennæ short in both sexes; scape and pedicel dark brown; flagellum whitish; antennæ with nine free flagellar segments beyond the elongate fusion segment; flagellar verticils much longer than the segments. Head light ashen gray.

Pronotum whitish. Mesonotal præscutum whitish, with a peculiar and very conspicuous dark brown pattern, including a pair of oval spots at near midlength of the segment, one on either side of the median line, and a broad sublateral area that extends behind onto the lateral border of the scutum and as a short spur along the suture; posterior sclerites of notum white. Pleura white. Halteres yellowish white throughout. Legs with the coxæ and trochanters white; fore femora and tibiæ snowy white, the tips broadly and conspicuously brownish black, the amount subequal on the two segments; on middle and posterior legs, the femoral tips are narrowly and less conspicuously darkened, the tibial tips similarly darkened, the latter area approximately twice as extensive as the former; tarsi snowy white, the outer segments dark brown; segments of leg with very long, outspreading setæ, white on the pale areas, dark brown on the darkened portions. Wings (Plate 1, fig. 22) whitish subhyaline, restrictedly but very strikingly patterned with dark brown, including a spot at origin of Rs and along the cord, more expanded on anterior cord; much narrower dark seams on Sc_2, R_2, and m; veins white, brownish black in the darkened areas. Macrotrichia of veins long and conspicuous. Venation: Sc_1 ending just before R_2, Sc_2 just beyond fork of Rs; Rs long, nearly square at origin; R_{1+2} elongate, considerably longer than R_{2+3+4}; R_{2+3} subequal to m-cu; cell M_1 short-petiolate; m-cu at or close to fork of M; vein 2d A very long, ending at near midlength of the wing, which is widest at this point.

Abdomen yellowish white, the genital segments in both sexes blackened; posterior borders of the segments narrowly more whitish; a velvety black spot covers most of disk of the fourth

tergite. Male hypopygium (Plate 3, fig. 43) with the basistyle, *b*, cylindrical, simple; outer dististyle, *od*, slender, the tip decurved into a slender spine; outer margin before apical spine with four or five slender appressed spines; inner dististyle, *id*, a little longer than the outer, very gradually narrowed outwardly. Gonapophyses, *g*, small, blackened, gently curved, the tips bifid, the outer spine a little larger and more powerful than the inner. Ædeagus small.

Habitat.—China (Szechwan).

Holotype, male, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, September 1, 1933 (*Graham*). Allotopotype, female. Paratopotypes, 7 males and females, August 16 to September 1, 1933.

The genus had not been recorded from China. This striking spectral insect requires no comparison with any described crane fly. I refer it to *Crypteria* chiefly on the venation, as the elongate vein 2d A and the position of m-cu. The only regional *Crypteria* is *C. claripennis* (Brunetti), readily told from the present fly by the entirely clear wings. The genera and subgenera of the Claduraria are now highly involved and our conceptions of the interrelationships will surely be changed as further types are discovered. The most recent general discussion is by Soot-Ryen,[6] which gives an excellent account of our present knowledge of the group.

RHABDOMASTIX (SACANDAGA) HOLOMELANIA sp. nov. Plate 1, fig. 23.

General coloration black, the thorax sparsely pruinose; antennæ, halteres, and legs black throughout; wings with a strong dusky tinge, the stigma poorly indicated, a little darker than the ground color; macrotrichia lacking on Rs, R_{2+3+4}, R_3, and R_4; Sc_1 ending opposite midlength of Rs; m-cu beyond midlength of cell 1st M_2.

Male.—Length, 4.2 to 4.4 millimeters; wing, 4.8 to 5.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ relatively short in both sexes, if bent backward not attaining the wing root; flagellar segments oval. Head black.

Entire thorax, including pleura, black, the surface sparsely pruinose. Halteres black throughout. Legs black. Wings (Plate 1, fig. 23) with a strong dusky tinge; stigma poorly in-

[6] Diptera from Arctic Siberia. The Norwegian North Polar Expedition with the "Maud," 1918–1925, Scientific results 5 No. 5 (1928) 4–6.

dicated, a little darker than the ground color; veins dark brown. Macrotrichia lacking on veins Rs, R_{2+3+4}, R_3, and R_4, excepting an occasional one on the last vein. Venation: Sc_1 ending about opposite midlength of Rs, Sc_2 a short distance from its tip; R_3 suberect, approximately twice its length beyond tip of R_{1+2}; R_4 arcuated, subequal in length to petiole of cell R_3; m-cu at from beyond midlength to near two-thirds the length of cell 1st M_2.

Abdomen black throughout.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Allotopotype, female. Paratopotypes, 2 males.

Rhabdomastix (*Sacandaga*) *holomelania* is most nearly allied to *R.* (*S.*) *minicola* Alexander (western China), which has the venation somewhat similar, differing in the uniformly blackened halteres of the present insect and in certain venational details, as the relation of vein R_3 to the tip of R_{1+2} and the position of m-cu some distance beyond midlength of cell 1st M_2.

MOLOPHILUS NIGROPOLITUS sp. nov. Plate 1, fig. 24; Plate 3, fig. 44.

Belongs to the *gracilis* group and subgroup; allied to *albibasis;* thorax and abdomen polished black; head dull gray; wings white, the prearcular field light yellow: vein 2d A short, ending approximately opposite the origin of Rs; male hypopygium with the tergite conspicuous, its apical portion narrowed into a depressed lobe, the margin of which is evenly, microscopically serrulate.

Male.—Length, 3.8 to 4.2 millimeters; wing, 4.6 to 5.

Rostrum and palpi black. Antennæ short, if bent backward not attaining the wing root, black throughout. Head uniformly dull gray.

Thorax uniformly polished black, only the restricted anterolateral pretergites and the dorsopleural membrane yellow. Halteres white, the knobs weakly more yellowish. Legs with the coxæ blackened; trochanters obscure yellow; femora black, their bases yellow, involving the basal fourth or approximately so; remainder of legs black. Wings (Plate 1, fig. 24) white, the prearcular field light yellow; veins conspicuous, dark brown. Venation: Sc_1 ending opposite R_2, Sc_2 only a short distance beyond origin of Rs; petiole of cell M_3 about twice the gently sinuous m-cu; vein 2d A short, ending opposite, or just beyond, origin of Rs.

Abdomen, including hypopygium, polished black. Male hypopygium (Plate 3, fig. 44) with the tergite, *9t*, conspicuous, the apical portion strongly narrowed into a depressed lobe, its margin evenly and microscopically serrulate; surface of tergite at base of lobe with long conspicuous setæ that exceed the lobe in length. Dorsal lobe *db*, of basistyle with apex very strongly curved upon itself to form an almost complete turn, the apex a slender black spine, with conspicuous pale membrane at base of spine. Inner dististyle, *id*, with the two arms long and slender.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Paratopotype, male.

The nearest known ally of the present fly is *Molophilus albibasis* Alexander (Saghalien), which is readily told by the less-polished body coloration, the uniformly blackened legs, and the distinct male hypopygium. I have illustrated the latter for comparison with the present fly (Plate 3, fig. 45). Note the difference in the conformation of the tergal lobe, which is expanded at apex and with the margin coarsely and irregularly serrate.

ILLUSTRATIONS

[Legend: *b*, Basistyle; *d*, dististyle; *db*, dorsal lobe of basistyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *m*, median appendage of ninth sternite; *od*, outer dististyle; *s*, sternite; *t*, tergite; *vd*, ventral dististyle.]

Plate 1

Fig. 1. *Trichocera sapporensis* sp. nov.; venation.
2. *Trichocera szechwanensis* sp. nov.; venation.
3. *Tipula (Vestiplex) optanda* sp. nov.; venation.
4. *Tipula (Vestiplex) immota* sp. nov.; venation.
5. *Tipula (Oreomyza) coxitalis* sp. nov.; venation.
6. *Tipula (Oreomyza) sternotuberculata* sp. nov.; venation.
7. *Tipula (Oreomyza) resupina* sp. nov.; venation.
8. *Tipula (Oreomyza) excetra* sp. nov.; venation.
9. *Tipula (Lunatipula) multisetosa* sp. nov.; venation.
10. *Tipula (Schummelia) strictiva* sp. nov.; venation.
11. *Tipula sindensis* sp. nov.; venation.
12. *Dolichopeza (Sinoropeza) pluricoma* sp. nov.; venation.
13. *Cylindrotoma aurantia* sp. nov.; venation.
14. *Limonia (Libnotes) immetata* sp. nov.; venation.
15. *Limonia (Limonia) tuta* sp. nov.; venation.
16. *Limonia (Rhipidia) synspilota* sp. nov.; venation.
17. *Dicranoptycha vulpes* sp. nov.; venation.
18. *Nipponomyia szechwanensis* sp. nov.; venation.
19. *Ula comes* sp. nov.; venation.
20. *Epiphragma (Epiphragma) bicinctifera* sp. nov.; venation.
21. *Grahamomyia bicellula* gen. et sp. nov.; venation.
22. *Crypteria spectralis* sp. nov.; venation.
23. *Rhabdomastix (Sacandaga) holomelania* sp. nov.; venation.
24. *Molophilus nigropolitus* sp. nov.; venation.

Plate 2

Fig. 25. *Trichocera sapporensis* sp. nov.; male hypopygium.
26. *Trichocera szechwanensis* sp. nov.; male hypopygium.
27. *Tipula (Vestiplex) optanda* sp. nov.; male hypopygium, details.
28. *Tipula (Vestiplex) optanda* sp. nov.; male hypopygium, details.
29. *Tipula (Vestiplex) immota* sp. nov.; male hypopygium, details.
30. *Tipula (Oreomyza) coxitalis* sp. nov.; male hypopygium, details.
31. *Tipula (Oreomyza) coxitalis* sp. nov.; male hypopygium, details.
32. *Tipula (Oreomyza) sternotuberculata* sp. nov.; male hypopygium, details.
33. *Tipula (Oreomyza) sternotuberculata* sp. nov.; male hypopygium, details.
34. *Tipula (Oreomyza) resupina* sp. nov.; male hypopygium, details.

PLATE 3

FIG. 35. *Tipula* (*Lunatipula*) *multisetosa* sp. nov.; male hypopygium, details.

36. *Tipula* (*Lunatipula*) *multisetosa* sp. nov.; male hypopygium, details.

37. *Tipula sindensis* sp. nov.; male hypopygium, dististyles.

38. *Limonia* (*Libnotes*) *immetata* sp. nov.; male hypopygium.

39. *Limonia* (*Rhipidia*) *synspilota* sp. nov.; male hypopygium.

40. *Nipponomyia szechwanensis* sp. nov.; male hypopygium.

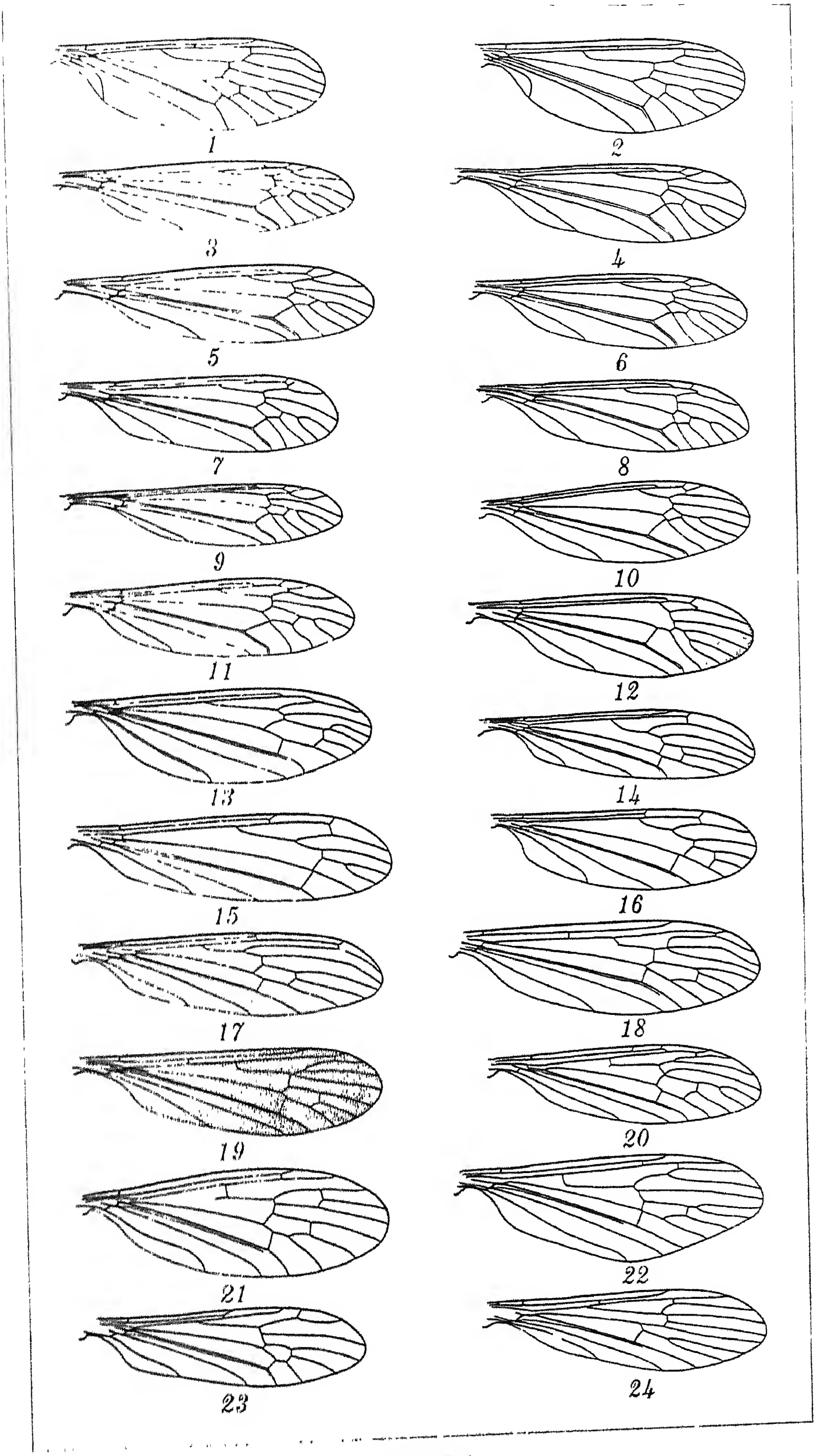
41. *Epiphragma* (*Epiphragma*) *bicinctifera* sp. nov.; male hypopygium.

42. *Grahamomyia bicellula* gen. et sp. nov.; male hypopygium.

43. *Crypteria spectralis* sp. nov.; male hypopygium.

44. *Molophilus nigropolitus* sp. nov.; male hypopygium.

45. *Molophilus albibasis* Alexander; male hypopygium.



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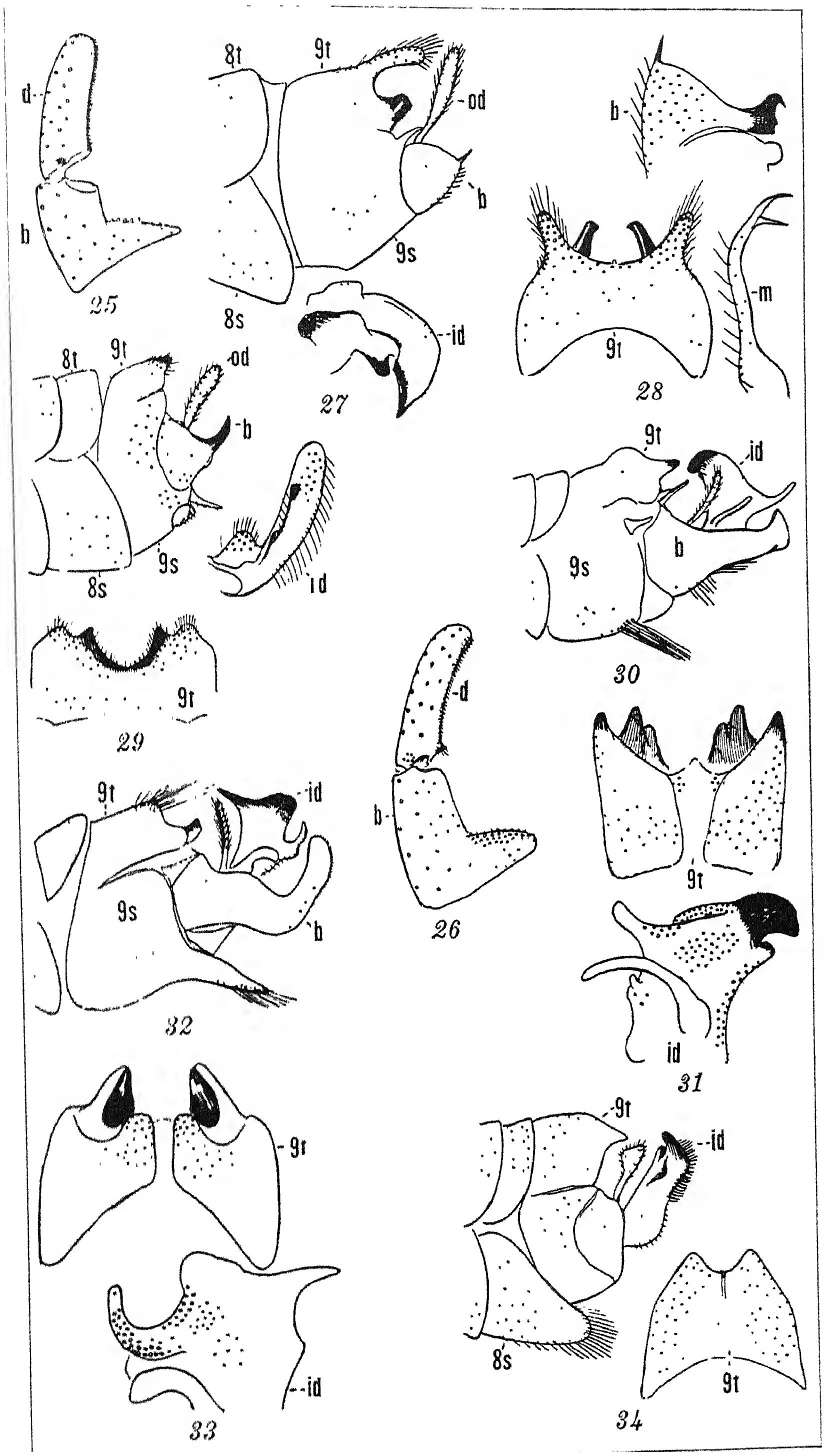
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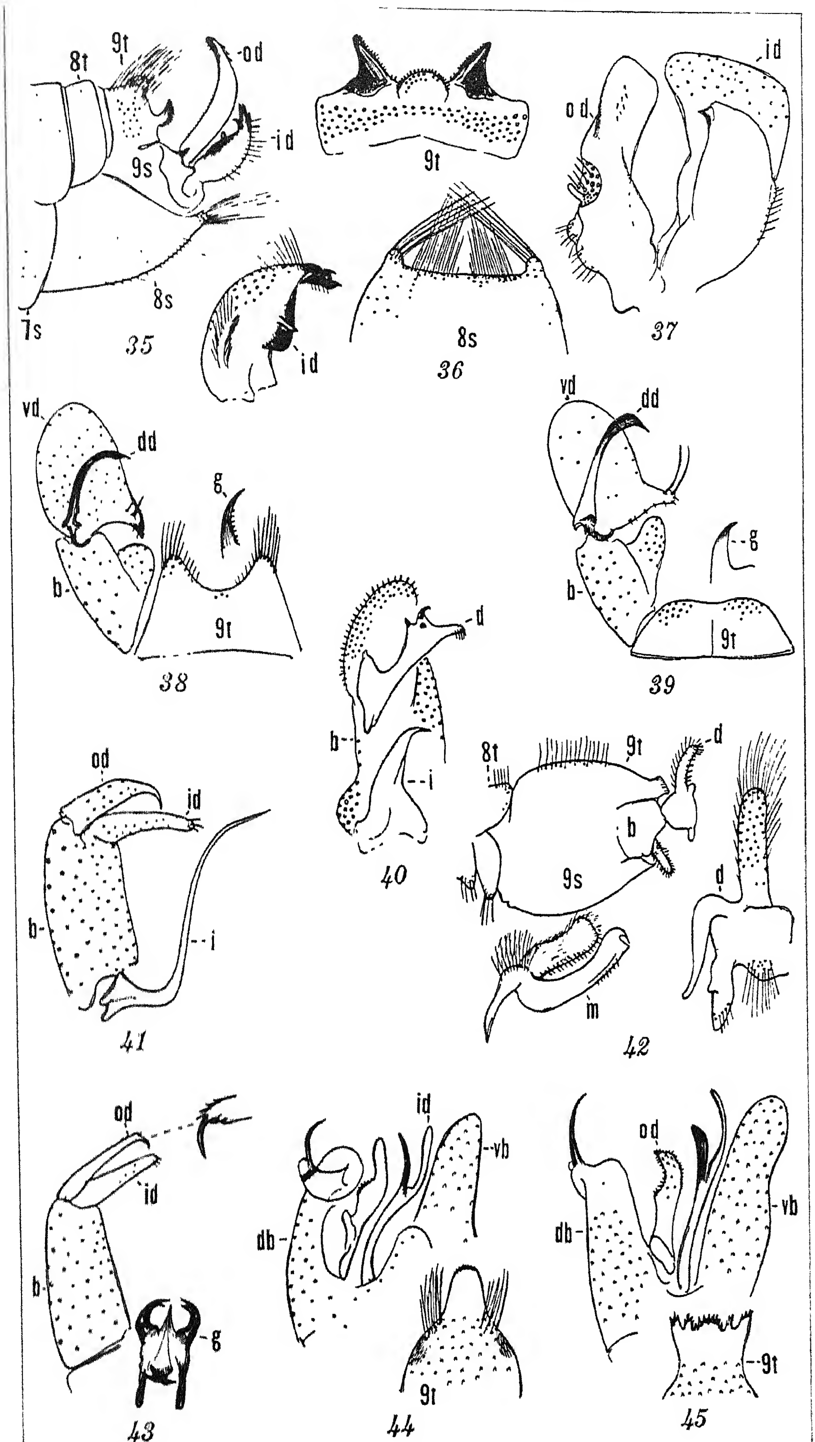
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PLATE 3.

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[New names and new combinations are printed in boldface.]

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